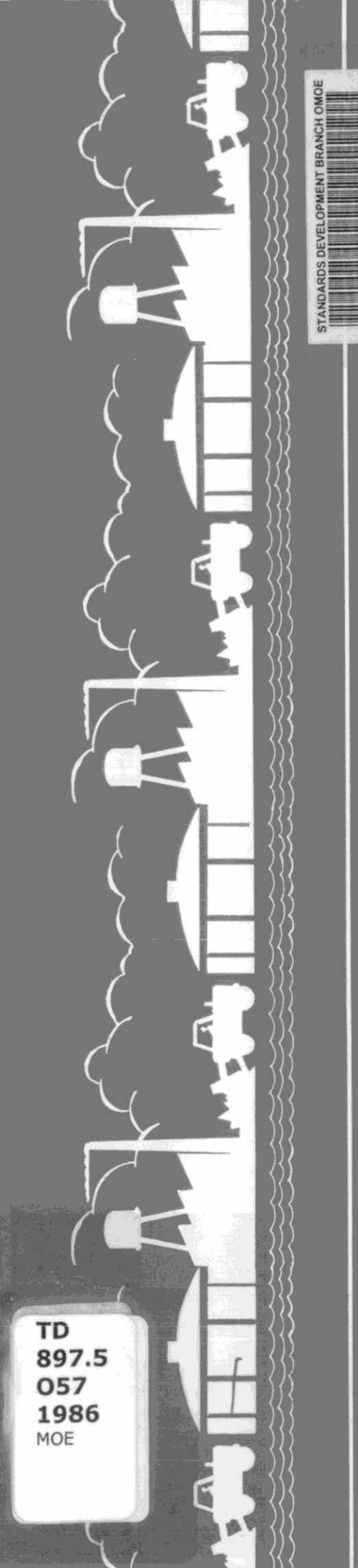
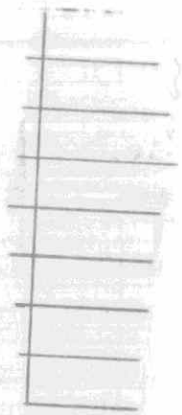


PROCEEDINGS

33rd Ontario Industrial Waste Conference

June 15-18, 1986
The Prince Hotel
Toronto, Ontario

Ontario
Ministry of the Environment
Hon. Jim Bradley
Minister
Rod McLeod
Deputy Minister



Proceedings
of the
Thirty-third
Ontario Industrial Waste Conference

held at

The Prince Hotel
Toronto, Ontario

June 15-18, 1986

Sponsored by the
Ontario Ministry of the Environment

CONTENTS

ONTARIO INDUSTRIAL WASTE CONFERENCE
HISTORICAL DATA

Location	Dates	Sponsor
Ontario Agriculture College, Guelph	1954 to 1956	Pollution Control Board of Ontario
Delawana Inn, Honey Harbour	1957 to 1963	Ontario Water Resources Commission, Water & Pollution Advisory Committee
Bigwin Inn, Lake of Bays	1964 & 1965	Ontario Water Resources Commission, Water & Pollution Advisory Committee
Park Motor Hotel, Niagara Falls	1966 & 1967	Ontario Water Resources Commission
Sheraton Brock Hotel, Niagara Falls	1968 to 1971	Ontario Water Resources Commission
Skyline Hotel, Toronto	1972 to 1974	Ontario Ministry of the Environment
The Prince Hotel, Toronto	1975 to 1986	Ontario Ministry of the Environment

Conference Chairman	Dates	Secretary/ Co-Ordinator
Dr. A.E. Berry	1954 to 1962	D.S. Caverly/M. Grove
D.S. Caverly	1963 to 1973	L.M. Tobias
K.H. Sharpe	1974 to 1976	M.J. Cathcart (1974)
D.P. Caplice	1977 & 1978	
	1975 to 1986	M.F. Cheetham
J.W. Giles	1979 to 1986	

Program Conveners

1960-1973 F.A. Voege
1974-1978 J.B. Patterson
1979-1986 R.C. Stewart

PREFACE TO THE PROCEEDINGS OF THE 33rd ONTARIO INDUSTRIAL WASTE CONFERENCE

Over 400 delegates and their spouses attended the 1986 edition of the Ontario Industrial Waste Conference which attracted representatives from industry, provincial and federal governments and academic institutions. The 20 papers that were delivered were well-received by the delegates who also appreciated the expertise of the session moderators in their handling of presentations and follow-up audience participation. Actual attendance was 438.

My thanks to all those who participated in the program, the speakers, session moderators, members of the Planning and Program Committees, the support staff, and especially the delegates and spouses, all of whom collaborated to make the 33rd OIW Conference most successful. The papers were first class, the interest of the delegates most appreciated by the speakers, and the general tenor of the whole Conference one of beneficial information exchange.

This printing of the Proceedings of the 33rd Conference concludes my tenure as Conference Chairman. It has been a real pleasure to be associated with the Conference and its participants over the past eight years. The fact that the Conference has only had five chairmen over its thirty-three year history, is a tribute to the support each chairman has had from his respective Planning and Program Committee members. My experience has been no different. I am most indebted to those who have worked with me to stage the last eight Conferences. Their dedication and commitment to the objectives set for the Conference have been the key to success. Without this, the Conferences with which I have been directly associated, would not have been so successful. We set goals, and achieved them. Ron Gotts, the present Conference Vice-Chairman, is assuming the Chairmanship. I wish him, and his associates, every success in the future.

On behalf of the Ministry, thank you for attending the 33rd Conference. The following Proceedings will provide you and your associates with a permanent record of the papers presented. The 34th Conference is scheduled for June 14-17, 1987, at the Prince Hotel in Toronto. You are invited to attend.

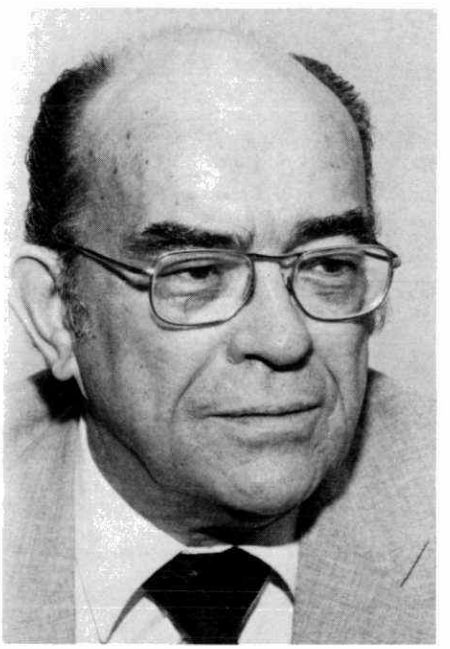
J. Walter Giles
Chairman

CONFERENCE PLANNING COMMITTEE

Conference Chairman
J.W. Giles,
Associate Deputy Minister,
Intergovernmental Relations
and Strategic Projects Division,
Ontario Ministry of the Environment

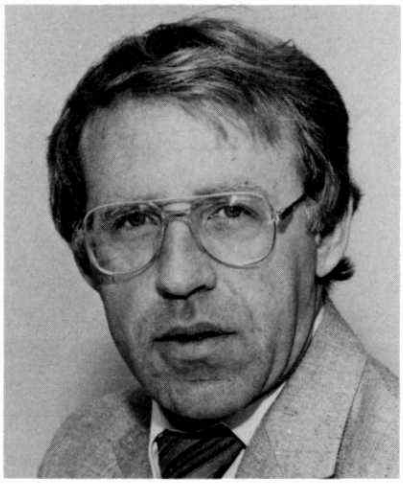
Conference Vice-Chairman
R.M. Gotts,
Director,
Waste Management Branch,
Ontario Ministry of the Environment

Program Convener
R.C. Stewart,
Manager Technical Support,
West Central Region,
Ontario Ministry of the Environment



Conference Co-Ordinator
M.F. Cheetham,
Administrator,
Freedom of Information Office,
Ontario Ministry of the Environment

TECHNICAL PROGRAM COMMITTEE



T.D. Armstrong, Manager,
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Environmental Approvals and Land
Use Planning Branch,
Environment Ontario

W.R. Balfour, Manager,
Municipal Waste Management
Policy Section,
Waste Management Branch,
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C.E. Duncan, Manager,
Emission Technology and
Reg. Development Section
Air Resources Branch,
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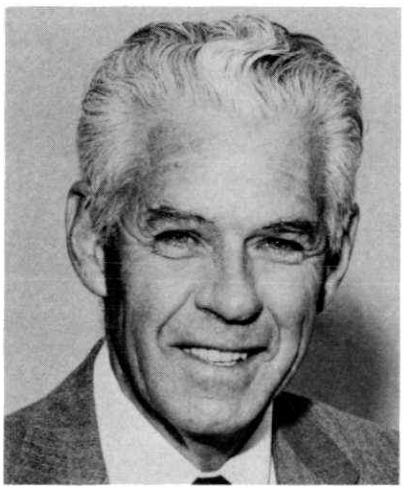
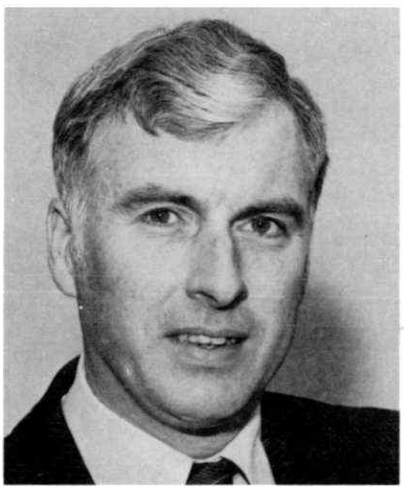


F.N. Durham, Manager,
Abatement South
Southwestern Region,
Environment Ontario, London



J. Hawley, Co-Ordinator,
Inorganic Industries, Water and
Wastewater Management Section,
Water Resources Branch,
Environment Ontario

THE PAPERS AND THE AUTHORS

at the

33rd ONTARIO INDUSTRIAL WASTE CONFERENCE

JUNE 1986

TORONTO, ONTARIO

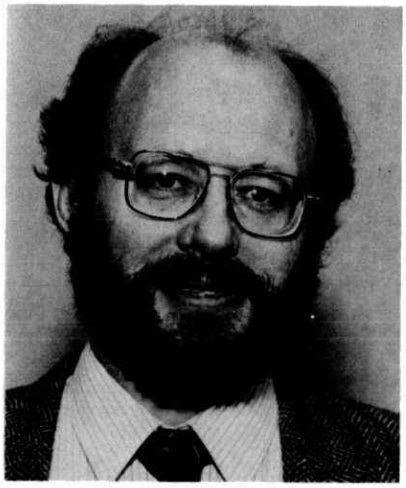
SESSION I – CHEMICAL MANAGEMENT

Moderator: Rod McLeod,
Deputy Minister,
Ontario Ministry of the Environment,
Toronto, Ontario

The Honourable Jim Bradley,
Ontario Minister of the Environment,
Toronto, Ontario

Dr. D.A. Chant, Chairman and
President, Ontario Waste
Management Corporation,
Toronto, Ontario

L. Whitby, Corporate Planning Group,
Environment Canada,
Hull, Quebec



Dr. B. Birmingham, Standards Co-
Ordinator, Hazardous Contaminants
Co-Ordination Branch,
Environment Ontario, Toronto

B. Thorpe, Supervisor,
New Substances Unit,
Hazardous Contaminants Branch,
Environment Ontario, Toronto

ONTARIO'S DRINKING WATER PROGRAM- IT'S PRESERVATION AND PROTECTION

by The Honourable Jim Bradley, Ontario Minister of the Environment, Toronto

I am pleased to be here this morning.

You work hard to develop practical methods of waste management and pollution control. An important part of my job is to ensure that Ontario makes the best use of your solutions.

Together, I think we make a pretty good team. I know that my job would be a lot harder without the innovations of the scientists, engineers, consultants and municipal officials assembled here today.

This morning's session allows me to fill you in on what I've been doing -- with particular attention to the Ontario government's initiatives in drinking water protection.

When it comes to Ontario's drinking water, we had some bad news over the past 10 months. Most of it came from the St. Clair-Detroit River system where the Dow Chemical spill of perchloroethylene into the St. Clair was followed by finding dioxins and furans in raw and treated water at some area treatment plants.

While the Dow Chemical spill did release toxics into the St. Clair River, no drinking water tested had contaminant levels exceeding any health-related standards. Nonetheless, the spill and the finding of dioxin shook public confidence in the quality of Ontario's drinking water.

The Peterson government has made protection of Ontario's drinking water a top priority.

Some of our initiatives in this area are related directly to water treatment. But most of our effort is designed to stop pollution at the source.

One of the key challenges ahead in water protection is the virtual elimination of persistent toxic substances from municipal and industrial discharges into waterways.

Some people may think this an unrealistic objective. They believe Ontario's industrial economy and our chemical-dependent society precludes any chance of an effective cleanup.

I disagree. Stopping the discharge of toxics-contaminated effluent into our waters will not be easy, nor will it be a reality overnight, but it is the only goal worth striving for in water protection.

To turn the tide against the contamination of our waters, we are developing policies that speak loudly and clearly to Ontario polluters.

Our message is this: Ontario waters are not a free waste disposal site.

The fact that an industry -- or municipal sewage treatment plant for that matter -- is located on the shores of an Ontario lake or river does not give that plant the right to ruin those waters for others. They especially do not have the right to put our drinking water at risk.

Good abatement technology is available, and I intend to insist upon its use.

Ontario needs stiffer penalties for those convicted of dumping industrial wastes into lakes and rivers. We will no longer be content to slap polluters on the wrist with the traditional small fine.

Instead, we are looking at ways to use fines as real deterrents that will strip polluters of any financial gain made by breaking our pollution laws. Under this tougher penalty structure, we will also be asking judges to jail flagrant offenders.

To see that those who break the law are caught, the Ministry's investigations and enforcement branch has been expanded.

All of this is in support of the effective water protection programs that we have developed to start the ball rolling on toxics' cleanup in Ontario. Let me outline some of the programs we now have underway.

A key element of our water policy is the package of regulations we are currently putting together to curb waste discharge into waterways.

We are now working in consultation with the affected parties on a system that will -- for the first time in Ontario -- cap the absolute amount of contamination each source may discharge. The standards will be based on two factors: current abatement capabilities, and impact on water quality.

We hope to have the first phase of this reform in place later this year and to have a comprehensive abatement program operating province-wide within three years.

Another important aspect of our control over toxic and hazardous waste was announced to you at last year's Industrial Waste Conference.

I would like to take a moment to remind you that under Regulation 309, anyone who produces solid hazardous waste that must be hauled off-site, or liquid industrial waste that is discharged into a sewer system, has until this coming September 17 to register with the Ministry the types and amounts of substances being produced.

Ministry staff tell me that completed application forms have not yet swamped our offices. The deadline is approaching, so be warned: After the 17th of September anyone who is producing liquid industrial waste or hazardous waste under these conditions and has not submitted the required forms, will be in violation of, the law.

This partial list highlights our efforts to control and reduce industrial discharge into our waterways. We are developing comprehensive discharge standards and regulations; we are improving our ability to track toxic substances back to the source; and we intend to come down hard on any who skirt the intent of our pollution laws.

Another important area of concern, which directly affects drinking water quality, centres on Ontario's aging water-related infrastructure systems.

We are approaching a critical juncture for Ontario's water and sewage facilities. Built through federal, provincial and municipal co-operation, Ontario's sewers, water mains and treatment plants have served residents well over the past forty or more years.

Now, though, many are nearing the end of their lifespan and are in need of assessment, repair and renewal.

Examples of deterioration abound. Old and outmoded combined sewer systems are overloading equally old sewage treatment plants, which, in turn, dump poorly treated effluent into our lakes and rivers. This pollution contributes to beach closings such as the ones we have seen in Toronto and across Ontario in recent summers.

Even more serious, watermain breaks, calcium build-up, and inflow and infiltration problems have put drinking water at risk in some instances.

Ministry of the Environment studies show that Ontario's $32 billion investment in underground water and sewage systems needs attention now if we are to avoid crisis situations down the road. In addition to the environmental risks of inaction, there is as well a heavy financial cost. It is estimated that rehabilitation and renewal programs save between 50 and 70 per cent of the cost of replacing systems left to deteriorate beyond repair.

As I see it, these factors -- the health and environmental risk and the monetary savings -- argue strongly for a quick start on a province-wide program of infrastructure assessment and rehabilitation.

What is called for is a long-term, multi-billion dollar assistance program so that municipalities can begin these works. Water and sewage facilities need upgrading, water and sewer system infrastructure must be rehabilitated, combined sewers separated, and storm water treated.

This is a long-term project. Municipal pollution control studies and needs assessment would take three to five years. They would help us set priorities for capital works projects in later years.

The cost of such a program is high. My ministry estimates that once re-construction gets fully underway, costs will average $90 million a year. Again, though, this figure is nowhere near the price tag we will leave for ourselves and our children if we decide to shirk this responsibility.

I have been negotiating with my federal counterparts to convince them to lend their much-needed assistance to this work.

Clearly the associated costs are too great for Ontario or the municipalities to shoulder alone. Given Ottawa's historical contribution to the building of our sewer and water systems and the transboundary nature of most of our waterways, I see good reason for federal help.

The facts are clear. Either we act responsibly and pay the substantial costs of rehabilitation now, or we pay much higher financial costs down the road, and put our health and environment at risk as well.

I hope Ottawa will soon lend its support to this program.

Up to now, I have been speaking almost exclusively about Ontario's efforts to protect the sources of our drinking water supply. The other vital aspect of our drinking water policy centres on water treatment initiatives.

Ontario's Drinking Water Surveillance Program, or DWSP as it is called, is providing us with a growing body of information on the quality of water from around the province.

DWSP regularly looks for well over a hundred possible drinking water contaminants in treated water across Ontario. When the Dow spill occurred, we were immediately able to expand our existing surveillance program to the Sarnia area. We were able as well, to respond to the requirements of the situation by adding dioxin and furan testing to the regular monitoring program.

Monitoring, though, is only part of the program. We also make sure that the results of these tests are made available to the public -- both when the news is good and when it is bad.

We do this because the public has a right to know, and because we welcome public comment in developing our water quality policies.

We are also seeking to further improve our drinking water treatment plants.

We are, for example, looking at ways to optimize conventional treatment efficiency and effectiveness. A recent study done on nine water treatment plants in the St. Clair - Detroit River area found that plant efficiency could be improved in some instances simply by devoting more attention to plant operations.

The study recommended closer communication between plant management and operations personnel, better monitoring and record-keeping and routine use of process evaluation, control and monitoring equipment.

We are also evaluating alternative treatment methods. One such investigation is, I am told, about to begin in Niagara Falls. Here, a pilot project will test the effectiveness of granular activated carbon treatment. Like many Ontarians, I am eager to know if this technique is capable of removing dioxin and other toxic contaminants in the low concentrations generally found in Ontario waters.

This, then, is what we have been doing to protect the quality of Ontario's drinking water. First, we are developing programs to curb polluters and stem contamination of our waterways at the source. Second, we are trying to engage the co-operation of the federal government for a long-range program to rehabilitate Ontario's multi-billion dollar investment in its water-related infrastructure. Third, we have initiated province-wide drinking water monitoring and surveillance programs, and fourth, we are investigating new treatment methods to enhance our current capabilities.

Many of you will no doubt contribute your talents to this effort. Together, we can clean up Ontario's waterways and assure the continued flow of good drinking water to Ontarians for years to come.

A PROGRESS REPORT ON THE ONTARIO WASTE MANAGEMENT CORPORATION

by
Dr. D.A. Chant, Chairman and President,
Ontario Waste Management Corporation,
Toronto, Ontario

FIRST OF ALL, I WANT TO SAY HOW PLEASED I AM TO BE SHARING THE PROGRAM THIS MORNING WITH ROD AND THE MINISTER. THEY HAVE BOTH PROVIDED US WITH AN IMPORTANT OVERVIEW OF THE INDUSTRIAL WASTE MANAGEMENT ISSUE, AND THE MINISTRY'S CURRENT PLANS AND ACTIVITIES. I HOPE TO BE ABLE TO ADD TO THIS THIS MORNING BY GIVING YOU A BRIEF UPDATE ON OWMC'S WORK, AS WELL AS TOUCHING ON A FEW ISSUES WHICH I KNOW ARE OF PARTICULAR INTEREST TO THIS AUDIENCE CONCERNING OUR ROLE IN THE WASTE MANAGEMENT BUSINESS.

FIRST OF ALL, AN UPDATE. WHEN I LAST SPOKE TO THIS CONFERENCE, WE WERE IN THE EARLY STAGES OF A COMPREHENSIVE SITE SELECTION AND FACILITIES DEVELOPMENT PROCESS. A GREAT DEAL OF WORK HAS BEEN COMPLETED SINCE THEN. AS YOU ALL KNOW, WE ANNOUNCED THE SELECTION OF OUR PREFERRED SITE IN THE TOWNSHIP OF WEST LINCOLN LAST SEPTEMBER, AND ARE NOW GATHERING AND ANALYZING MORE SITE-SPECIFIC DATA THAT WE REQUIRE FOR THE COMPLETION OF OUR ENVIRONMENTAL ASSESSMENT UNDER THE ENVIRONMENTAL ASSESSMENT ACT. I HOPE THAT THIS FINAL STAGE OF THE PROCESS CAN BE COMPLETED THIS FALL, IN TIME FOR OUR DRAFT PROPOSALS TO BE REVIEWED BY THE PUBLIC AND GOVERNMENT AGENCIES BEFORE

THE END OF THIS YEAR. THIS LIKELY WOULD MEAN THAT FORMAL PUBLIC HEARINGS UNDER THE ENVIRONMENTAL ASSESSMENT ACT WOULD BEGIN SOME TIME NEXT YEAR ON THESE PROPOSALS.

THE PROCESS HAS TAKEN A LOT OF TIME TO ARRIVE AT THIS POINT, AND I THINK IT IS WORTH UNDERLINING A FEW REASONS WHY I BELIEVE THIS SIMPLY HAD TO BE THE CASE. FIRST, THE ENVIRONMENTAL ASSESSMENT ACT HAS VERY SPECIFIC AND DEMANDING REQUIREMENTS AND WE MUST ENSURE THAT THESE REQUIREMENTS HAVE BEEN MET BEFORE SUBMITTING OUR PROPOSALS FOR FULL PUBLIC REVIEW. FOR EXAMPLE, UNDER THE TERMS OF THE EA ACT, OWMC MUST NOT ONLY PROVIDE SPECIFIC DETAILS ON THE TYPE OF WASTE MANAGEMENT SYSTEM WE ARE PROPOSING, BUT WE MUST ALSO PRESENT EVIDENCE THAT WE HAVE RESEARCHED AND ANALYZED REASONABLE ALTERNATIVES TO OUR PROPOSED SYSTEM. ULTIMATELY, AFTER WEIGHING THE VARIOUS ADVANTAGES AND DISADVANTAGES OF THE ALTERNATIVE SYSTEMS, WE MUST DEMONSTRATE THAT THE SYSTEM WE ARE PROPOSING IS A SAFE AND SUITABLE ONE.

WHEN WE BEGAN OUR WORK IN 1982 AFTER REJECTING THE SITE IN SOUTH CAYUGA, I WAS VERY AWARE OF THE FACT THAT SEVERAL JURISDICTIONS IN NORTH AMERICA HAD TRIED TO

SITE AND BUILD SIMILAR FACILITIES. THESE ATTEMPTS ALL FAILED, FOR VARIOUS TECHNICAL AS WELL AS POLITICAL REASONS. IT WAS CLEAR TO ME THEN AND STILL IS NOW THAT IF WE ARE GOING TO BE SUCCESSFUL IN OUR WORK, WE MUST ENSURE THAT THE JOB HAS BEEN DONE THOROUGHLY, OPENLY AND IN ACCORDANCE WITH ALL OF THE VARIOUS STANDARDS AND REQUIREMENTS A PUBLIC AGENCY SUCH AS OURS WILL BE EXPECTED TO MEET. THE JOB MUST BE DONE RIGHT, OR WE WILL HAVE SET THE PROCESS BACK AT LEAST ANOTHER DECADE, IN MY VIEW.

THIS PROCESS HAS REALLY INVOLVED TWO KEY ACTIVITIES - THE SEARCH FOR A SUITABLE SITE AND THE SELECTION OF VARIOUS TECHNOLOGIES CAPABLE OF TREATING AND DISPOSING OF ONTARIO'S WASTES ON THIS SITE. WHILE I DON'T WANT TO GO INTO GREAT DETAIL, I THINK IT WOULD BE USEFUL TO SPEND THE NEXT FEW MINUTES TALKING ABOUT HOW WE APPROACHED BOTH THESE ACTIVITIES.

FIRST, I'LL BEGIN WITH THE SELECTION OF THE TECHNOLOGIES FOR OUR PROPOSED FACILITY. I THINK IT IS IMPORTANT TO POINT OUT THAT THERE ARE NO WASTE TREATMENT FACILITIES ANYWHERE IN NORTH AMERICA THAT PROVIDE THE

FULL ARRAY OF TREATMENT AND DISPOSAL SERVICES NECESSARY TO HANDLE THE WIDE VARIETY OF ORGANIC AND INORGANIC WASTES GENERATED IN ONTARIO. WE HAVE LOOKED AT FACILITIES IN WESTERN EUROPE, THE UNITED STATES, JAPAN AND GREAT BRITAIN, AND HAVE EVALUATED OVER 100 DIFFERENT TECHNOLOGIES BEFORE SELECTING THOSE WE FEEL SHOULD BE INCORPORATED IN AN ONTARIO FACILITY.

AT THE BEGINNING OF THIS PROCESS, WE DECIDED THAT ONLY THOSE TECHNOLOGIES THAT HAD PROVEN THEMSELVES CAPABLE OF OPERATING IN A COMMERCIAL ENVIRONMENT WOULD BE EXAMINED IN MORE DETAIL. ULTIMATELY, THIS LED TO THE SELECTION OF FOUR MAJOR COMPONENTS FOR THE PLANT:

- A ROTARY KILN INCINERATION SYSTEM TO DESTROY ORGANIC WASTES;

- A PHYSICAL/CHEMICAL TREATMENT PLANT INVOLVING A SERIES OF TREATMENT PROCESSES TO DETOXIFY INORGANIC WASTES;

- A SOLIDIFICATION PLANT WHERE THE TREATED WASTE RESIDUES FROM THESE TREATMENT PROCESSES WILL BE SOLIDIFIED; AND

- AN ENGINEERED LANDFILL WHERE THE SOLIDIFIED WASTE RESIDUES WILL BE DEPOSITED.

THE SELECTION OF THESE TECHNOLOGIES WAS ONLY THE BEGINNING. WE SOON FACED TWO CRITICAL QUESTIONS - HOW BIG SHOULD THE PLANT BE AND SHOULD WE THINK IN TERMS OF A CENTRALIZED FACILITY, OR A SERIES OF SMALLER, MINI-FACILITIES LOCATED THROUGHOUT THE PROVINCE?

DETERMINING THE ULTIMATE SIZE OF THE PLANT HAS BEEN A DIFFICULT AND COMPLEX QUESTION TO RESOLVE. RECOGNIZING THE UNCERTAINTY THAT EXISTS IN THE WASTE MANAGEMENT BUSINESS, GIVEN THAT ABOUT 80 GENERAL WASTE STREAMS ARE PRODUCED BY ABOUT 16,000 PLANTS, AND THE LACK OF SPECIFIC PLANT-BY-PLANT DATA ON WASTE CHARACTERISTICS AND QUANTITIES, WE SET OUT TO DETERMINE OUR FACILITY CAPACITY GUIDED BY THREE KEY PRINCIPLES.

FIRST, WE MUST AVOID EXCESS CAPACITY. MANY PLANTS STARTING UP IN EUROPE EXPERIENCED THIS PROBLEM EVEN THOUGH I BELIEVE OUR DATA BASE ON WASTE QUANTITIES IS FAR MORE COMPLETE THAN ANY OTHER JURISDICTION IN THE WORLD. SECOND, WE FELT THE FACILITY MUST BE CAPABLE OF EXPANSION IF THIS PROVES TO BE NECESSARY, WITH MINIMAL COST.

FOR THIS REASON, WE SELECTED TECHNOLOGIES THAT FAVOUR INCREASED CAPACITY THROUGH EXTRA SHIFTS, RATHER THAN THE CONSTRUCTION OF NEW INSTALLATIONS. AND FINALLY, WE FELT THE PLANT MUST BE CAPABLE OF TREATING ALL TYPES OF WASTE PRODUCED IN THE PROVINCE THAT REQUIRE TREATMENT EVEN THOUGH WE WILL NOT BE RECEIVING ALL AMOUNTS PRODUCED. AS A PUBLIC AGENCY, WE MUST HAVE THE CAPABILITY TO DESTROY AND DISPOSE OF ANY TYPE OF WASTE PRODUCED IN THE PROVINCE, NO MATTER HOW EXPENSIVE OR COMPLEX IT MAY BE TO DO SO.

I BELIEVE THESE ARE SENSIBLE GUIDELINES, THAT HAVE RESULTED IN THE DESIGN OF A FACILITY WHICH WILL HAVE AN INITIAL CAPACITY TO TREAT 80,000 TONNES OF WASTE PER YEAR, RAISING TO 150,000 TONNES BY INCREASING SHIFTS AND WITH THE ABILITY TO EXPAND UP TO 300,000 TONNES PER YEAR BY MODULAR EXPANSION IF THIS PROVES TO BE NECESSARY. THIS REPRESENTS A RELATIVELY SMALL PERCENTAGE OF THE TOTAL VOLUME OF WASTES THAT APPEAR TO BE GENERATED IN THE PROVINCE EACH YEAR, AND IS IN MY VIEW A PRUDENT ESTIMATE FOR ENTRY INTO THE MARKETPLACE.

THE SECOND QUESTION WE WRESTLED WITH CONCERNED THE ISSUE OF A CENTRALIZED VERSUS A DECENTRALIZED FACILITY.

THIS IS AN ISSUE WHICH HAS COME UP FREQUENTLY IN THE WEST LINCOLN COMMUNITY IN RECENT MONTHS. RESIDENTS OBVIOUSLY WANT TO KNOW WHY WE FAVOUR A CENTRALIZED FACILITY IN WEST LINCOLN, AS OPPOSED TO A NUMBER OF SMALLER FACILITIES LOCATED ELSEWHERE ACROSS THE PROVINCE.

THERE ARE SEVERAL REASONS FOR THIS. FIRST, MOST OF ONTARIO'S INDUSTRIAL WASTES ARE GENERATED IN THE SOUTHERN PART OF THE PROVINCE. WASTE GENERATION FIGURES IN OTHER REGIONS OF ONTARIO RAISE SERIOUS QUESTIONS ABOUT THE ECONOMIES OF SCALE AND SAFETY OF OPERATION FOR SMALLER FACILITIES. IN OUR VIEW, THERE MAY NOT BE SUFFICIENT VOLUMES OF VARIOUS TYPES OF WASTES TO JUSTIFY REGIONAL FACILITIES THORUGHOUT THE PROVINCE. A CENTRALIZED FACILITY ALSO HAS THE ADVANTAGE OF A SINGLE, UNIFIED MANAGEMENT AND OPERATION SYSTEM, A SINGLE EFFLUENT AND EMISSIONS MONITORING SYSTEM, AND LESS IMPACT THAN WOULD OCCUR WITH SEVERAL SMALLER FACILITIES. AND FINALLY, I BELIEVE IT WOULD BE VIRTUALLY IMPOSSIBLE TO HANDLE THE INTENSE PUBLIC CONSULTATION AND HEARINGS PROCESS REQUIRED IN A MULTI-SITE PROCESS INVOLVING A NUMBER OF DIFFERENT COMMUNITIES. I NEED NOT TELL YOU WHAT IT'S LIKE HANDLING JUST ONE.

THIS LEADS ME TO THE SITE SELECTION PROCESS ITSELF, AND OUR REASONS FOR THE WEST LINCOLN DECISION ANNOUNCED LAST SEPTEMBER. FIRST, PERHAPS I SHOULD COMMENT ON OUR DECISION EARLY IN THE PROCESS TO CONCENTRATE OUR SEARCH WITHIN ONTARIO'S GOLDEN HORSESHOE REGION WHICH STRETCHES FROM OSHAWA IN THE EAST TO NIAGARA FALLS IN THE SOUTHWEST. THIS DECISION WAS BASED ON THE ASSURANCE BY OUR CONSULTANTS THAT WE COULD FIND THE SUITABLE HYDROGEOLOGICAL CONDITIONS REQUIRED FOR OUR FACILITY WITHIN THE GOLDEN HORSESHOE, AND ON THE FACT THAT APPROXIMATELY 70 PERCENT OF ONTARIO'S WASTES ARE GENERATED WITHIN THIS HIGHLY INDUSTRIALIZED REGION. TO US IT MADE SENSE TO LOCATE A FACILITY AS CLOSE AS POSSIBLE TO THE MAJOR SOURCE OF WASTE GENERATION, PROVIDED OF COURSE THAT WE COULD FIND A SAFE AND SUITABLE SITE THERE.

THE SEARCH PROCESS HAS INVOLVED THE EVALUATION OF 152 POSSIBLE SITE AREAS IN THE GOLDEN HORSESHOE, AND A DETAILED CONSIDERATION OF EIGHT CANDIDATE SITES WHICH WE ANNOUNCED IN MARCH, 1984: ONE IN MISSISSAUGA, THREE IN MILTON, TWO IN WEST LINCOLN AND TWO IN NIAGARA FALLS. IN MAY 1985, THE MISSISSAUGA SITE WAS REJECTED AFTER OUR DRILLING PROGRAM REVEALED SEVERAL DRAWBACKS WITH THE HYDROGEOLOGICAL CONDITIONS ON THE SITE.

THE SELECTION OF THE WEST LINCOLN SITE LAST SEPTEMBER FOLLOWED THE EVALUATION OF MORE THAN 150 SITE SELECTION FACTORS AND THE PRODUCTION OF MORE THAN 50 TECHNICAL REPORTS ANALYZING THESE FACTORS AND DESCRIBING HOW THEY WERE INCORPORATED IN THE SITE SELECTION PROCESS.

FROM THE START OF THIS EXERCISE, IT BECAME CLEAR TO ME THAT THERE WAS NO SUCH THING AS AN ABSOLUTELY "PERFECT" SITE FOR THE FACILITY. IN NARROWING THE SEARCH FROM ALL OF ONTARIO TO A SINGLE SITE, MANY TRADE-OFFS HAD TO BE ANALYZED AND WEIGHED. IN THE FINAL ANALYSIS, THE CHOICE CAME DOWN TO EITHER THE WEST LINCOLN SITE, OR A COMBINED SITING OPTION INVOLVING TWO SITES IN NIAGARA FALLS.

THIS TURNED OUT TO BE A VERY TOUGH CHOICE INDEED. FOR EXAMPLE, THE NIAGARA FALLS SITES HAD BETTER LOCAL TRANSPORTATION ACCESS ROUTES, BUT THE WEST LINCOLN SITE HAD DEEPER, MORE CONSISTENT AND UNIFORM CLAY SOILS. THE NIAGARA FALLS SITES WERE LOCATED IN A MORE INDUSTRIALIZED AREA, WHILE THE WEST LINCOLN SITE IS IN A MORE AGRICULTURAL, RURAL SETTING. THE AIR DISPERSION CHARACTERISTICS IN NIAGARA FALLS WERE NOT AS GOOD AS

WEST LINCOLN'S. MORE RESIDENTS WOULD HAVE BEEN DISPLACED IN NIAGARA FALLS THAN WEST LINCOLN.

IN THE FINAL ANALYSIS, WE GAVE GREATER WEIGHT TO THE FACTORS RELATING TO SAFETY AND HUMAN HEALTH, THAN TO THE FACTORS RELATING TO POSSIBLE OFF-SITE SOCIO-ECONOMIC IMPACTS. WHAT FINALLY TIPPED THE BALANCE IN FAVOUR OF WEST LINCOLN IS THE FACT THAT THE SITE IS UNDERLAIN BY AT LEAST 30 METRES OF DEEP, UNIFORM AND CONSISTENT CLAY SOILS. OUR HYDROGEOLOGICAL CONSULTANT ESTIMATES THAT IT WOULD TAKE LITERALLY HUNDREDS TO THOUSANDS OF YEARS FOR ANY LEACHATE FROM OUR LANDFILL TO SEEP THROUGH THESE SOILS TO THE BEDROCK AND AQUIFER BELOW.

IN CONTRAST, THERE WAS SOME UNCERTAINTY ABOUT THE CONSISTENCY OF THE CLAY SOILS AT THE NIAGARA FALLS SITES - OUR DRILLING PROGRAM REVEALED SOME SAND SEAMS RUNNING THROUGH THESE SOILS, WHICH POTENTIALLY COULD PROVIDE CONTAMINANTS WITH A PATHWAY TO THE ENVIRONMENT. THIS UNCERTAINTY SIMPLY COULD NOT BE IGNORED, AND BECAME AN IMPORTANT CONTRIBUTING FACTOR IN OUR DECISION TO GO WITH WEST LINCOLN.

NOW, WHERE DO WE GO FROM HERE? SINCE SEPTEMBER, WE HAVE BEEN GATHERING MORE SITE-SPECIFIC DATA THAT IS REQUIRED FOR THE COMPLETION OF OUR ENVIRONMENTAL ASSESSMENT. OVER THE NEXT FEW MONTHS, WE WILL BE CONDUCTING PUBLIC WORKSHOPS TO DISCUSS THIS INFORMATION WITH AREA RESIDENTS, AND TO SEEK THEIR COMMENTS ON THE VARIOUS MITIGATION AND MONITORING PROGRAMS THAT COULD BE PUT IN PLACE TO REDUCE THE IMPACTS TO THE LOWEST POSSIBLE LEVEL. WE EXPECT THIS WORK WILL BE COMPLETED IN THE FALL WITH THE RELEASE OF A DRAFT ENVIRONMENTAL ASSESSMENT PROPOSAL FOR REVIEW BY THE PUBLIC AS WELL AS GOVERNMENT AGENCIES, PRIOR TO ITS FORMAL SUBMISSION TO THE MINISTER. PUBLIC HEARINGS UNDER THE ENVIRONMENTAL ASSESSMENT ACT WILL THEN FOLLOW.

WITH THIS QUICK SUMMARY OF OUR WORK, I THOUGHT IT MIGHT BE HELPFUL TO USE THE REMAINING FEW MINUTES OF MY TIME THIS MORNING TO TOUCH ON TWO KEY ISSUES THAT I KNOW ARE OF PARTICULAR INTEREST TO THIS AUDIENCE.

THE FIRST ISSUE RELATES TO ENVIRONMENTAL REGULATIONS. ROD AND THE MINISTER HAVE BOTH SUMMARIZED FOR YOU THIS MORNING THE MINISTRY'S WORK ON THE REGULATION ISSUE, WHICH IS OF VITAL INTEREST BOTH TO YOU AND TO OWMC.

AS WE HAVE OFTEN BEEN TOLD, BOTH BY GENERATORS, WASTE TREATERS AND THE GENERAL PUBLIC, TREATMENT AND DISPOSAL FACILITIES CANNOT AND WILL NOT FUNCTION PROPERLY UNLESS REGULATIONS AND ENFORCEMENT ARE IN PLACE THAT REQUIRE THE DIRECTION OF CERTAIN TYPES OF INDUSTRIAL WASTE TO PROPER FACILITIES.

I BELIEVE IT GOES WITHOUT SAYING THAT IF A WASTE GENERATOR HAS THE LOW-COST OPTION OF DISPOSING OF HIS WASTE IN A MUNICIPAL SEWER SYSTEM OR MUNICIPAL LANDFILL VERSUS THE OPTION OF SENDING HIS WASTE FOR PROPER TREATMENT AT A RELATIVELY HIGHER COST, HE WILL OPT FOR THE FIRST OPTION EVERY TIME. BUT I ALSO THINK IT IS IMPORTANT TO UNDERSTAND THE SYMBIOTIC RELATIONSHIP BETWEEN SUCH A FACILITY AND SPECIAL WASTE REGULATIONS. REGULATIONS CANNOT BE TIGHTENED IF A PROPER TREATMENT FACILITY OR OTHER OPTION IS NOT IN PLACE, AND A FACILITY CANNOT BE VIABLE WITHOUT TIGHTENING REGULATIONS. AS STATED RECENTLY BY A SENIOR OFFICIAL OF THE A. D. LITTLE CONSULTING FIRM IN THE U.S., "WE CANNOT HAVE A HAZARDOUS WASTE BUSINESS WITHOUT REGULATIONS AND ENFORCEMENT; NEITHER CAN WE HAVE EFFECTIVE REGULATIONS AND ENFORCEMENT WITHOUT A HAZARDOUS WASTE BUSINESS." THE TWO GO HAND IN HAND.

I BELIEVE THIS PLACES A SPECIAL IMPORTANCE ON DISCUSSIONS BETWEEN OWMC, WASTE GENERATORS AND THE MINISTRY AS WE MOVE TOWARDS THE COMMISSIONING OF AN OWMC PLANT. THIS MUST BE ACCOMPLISHED IN A MEASURED, DELIBERATE WAY, AND I AM VERY ENCOURAGED, AS I KNOW THE MINISTRY IS AS WELL, WITH THE RESPONSE THAT REGULATION 309 HAS RECEIVED ACROSS THE PROVINCE AS WE BEGIN MOVING IN THIS DIRECTION.

THIS LEADS ME TO THE SECOND ISSUE THAT I WOULD LIKE TO MENTION - NAMELY, THE IMPACT OUR FACILITY WILL HAVE ON THE WASTE MANAGEMENT MARKETPLACE IN ONTARIO.

IN OUR DISCUSSIONS WITH GENERATORS, HAULERS, RECYCLERS AND TREATERS OVER THE PAST FIVE YEARS, SOME HAVE EXPRESSED CONCERN THAT OUR FACILITY WILL HAVE A NEGATIVE EFFECT ON THEIR BUSINESS. MY FEELINGS ARE THE EXACT OPPOSITE, FOR SEVERAL REASONS.

THE ESTABLISHMENT OF AN OWMC FACILITY, COMBINED WITH TIGHTER REGULATIONS, WILL NO DOUBT CHANGE THE ENTIRE ECONOMICS OF WASTE MANAGEMENT IN ONTARIO. MORE WASTE WILL REQUIRE HAULING AND TREATMENT, WHICH IN MY VIEW CONSTITUTES AN INCREASED MARKET OPPORTUNITY FOR

THOSE IN THE WASTE TRANSPORTATION AND TREATMENT BUSINESSES. AS WELL, THE PRESENCE OF AN OWMC FACILITY WILL ALSO HAVE AN EFFECT ON WASTE REDUCTION AND RECYCLING PRACTICES, CAUSING A POSITIVE IMPACT IN MY VIEW ON THE WASTE RECYCLING BUSINESS IN PARTICULAR.

IN SHORT, I BELIEVE THE WASTE MANAGEMENT MARKET WILL CHANGE SIGNIFICANTLY AND POSITIVELY IN THE YEARS AHEAD. HOWEVER, I SIMPLY DON'T BELIEVE THAT ONTARIO'S INDUSTRIAL WASTE PROBLEM CAN BE SOLVED BY ONE FACILITY ALONE. THERE WILL BE PLENTY OF POSITIVE OPPORTUNITIES FOR ALL THE ACTORS ON THE STAGE. BUT A CONCERTED EFFORT BY EVERYONE INVOLVED IN THIS ISSUE, FROM REGULATOR TO TREATER, IS REQUIRED IF WE ARE TO BE SUCCESSFUL IN COMING TO GRIPS WITH THE HAZARDOUS WASTE PROBLEM IN THIS PROVINCE.

CRADLE-TO-GRAVE MANAGEMENT OF CHEMICALS

by

Leslie Whitby

Senior Toxic Chemicals Issue Manager

Environment Canada

I would like to outline for you today a consultation project undertaken by Environment Canada to address the toxic chemicals issue. But let me first take you back to the situation that we in governments, and any other person with an interest in this issue, finds themselves.

Toxic chemicals is a highly complex issue with broad scientific, economic and social dimensions and conflicts. It is an issue that rises at one time as PCB's, then the next day as hazardous waste disposal, drinking water quality, dioxins, spills or a pesticide warehouse fire. Because it is so multi-dimensional with a focus that changes almost daily, it is characterized by high public concern about the impacts of these chemicals on their health and their environment. It is also characterized by public distrust of all of the institutions who is one way or another deal with these chemicals. It is clear in the public's mind that no one group is solving this problem in a credible manner. It is clear to those of us who deal with the issue on a daily basis that no one of us has all the tools to solve the problem alone. Since we all share responsibility - as governments, as industry, as environmental advocates, as consumers - for chemicals in our society, we must share the expertise, the knowledge and the tools in order to solve the problems chemicals create.

I would like to outline for you a consultation project initiated by Environment Canada which is resulting in a growing consensus on how to deal with and resolve this complex issue. The need to link economic and environmental decision-making is known to us all; the opportunities and the how we do that is something we are defining better as time goes on. However, in this country, we lack formal institutions where all the interests in a particular issue may come together to solve it. We have tended to operate bilaterally or multilaterally with sectors that have like interests - federal governments with provincial governments, provincial governments with industry, governments with public interest groups.

About a year ago, senior representatives of federal and provincial governments, industry, public interest groups, academics and consultants developed a process designed to link environmental and economic decision-making and to allow the diverse interests - the stakeholder - in an issue to develop win/win solution that all participants could implement. The process became known as the Niagara Process after the location at which the developed it. There was also a very strong feeling by the process developers that the most important issue that needed to be handled in this manner was toxic chemicals.

With the broad consensus of the stakeholders to tackle toxic chemicals, representatives of stakeholder groups started in September of 1985 meeting monthly under the guidance of a neutral facilitator.

Participants were:

Federal government - Environment Canada
Health and Welfare
Regional Industrial Expansion

Provincial government - Ontario Ministry of Labour
Quebec Environment

Industry - Imperial Oil, Canadian Manufacturing Association,
- Polysar-Coruna, Petroleum Association for Conservation of the Canadian Environment
- Dow Chemicals
- Canadian Chemical Producers Association, Canadian Agricultural Chemicals Association

Public Interest Groups - Friends of the Earth
- Conservation Council of New Brunswick
- Consumers' Association of Canada, PMAB

Labour - Energy and Chemical Workers' Union

Other - Insurance Bureau of Canada
- Federation of Associations for the Canadian Environment

Resource People - Facilitator - Niagara Institute
- Writer

Project Objectives

Result was a discussion document entitled "From Cradle-to-Grave: A Management System for Chemicals" that:

- has multistakeholder consensus on key requirements for managing chemicals;
- outlines guiding principles for future policies
  - ° compatible with social and economic aspirations
  - ° contains the risk to health and life-sustaining capacity of the environment;
- sets out a multistakeholder approach for identifying and prioritizing issues;
- identifies strategies for implementation.

The project approach reflected the new approach

- Multipartite in structure
- Outside facilitator
- Consensus seeking
- Constituent groups
- Difficult social issue
- Action oriented
- Comprehensive (cradle-to-grave)

Key elements of the management approach to chemicals

1. The problem is societal in nature - a comprehensive/ integrated approach
2. Working together - no one segment can develop the required solutions and implement.
3. Emphasis on prevention.
4. Data generation and sharing important - right to know can be balanced with confidential business information.
5. Priority setting process required and objectives set for action.
6. Move to limitations on exposure - decisions in scientific uncertainty.
7. Cost/economic impacts are important - cost of inaction.

8. Range of actions possible - voluntary through to regulatory - effectiveness and credibility are important.
9. Life-cycle concept - a critical tool to preventive approach.
10. Move to balance emphasis on all stages of the life-cycle.
11. It isn't only new chemicals - existing also important.
12. Compensation to innocent victims and environmental clean-up must be resolved.
13. Harmonizing legislative frameworks/jurisdictions important.
14. Evaluation and monitoring - multi-phased.

Two-pronged approach

- Clean-up current problems
- Anticipate and prevent new ones

An approach to manage

- Individual chemicals throughout their life-cycle
- Manage the stages of the life-cycle.

The life-cycle of chemicals became our analytical tool for structuring our approach. The life-cycle is shown in Figure 1.

Some of the key features of each stage of the life-cycle are:

Research and Development: Laboratory stage of a chemical

- synthesis
- potential use/hazard
- worker health/safety
- alternatives
- waste as resource

Introduction: Entry to trade

- market trials
- efficiency trials
- health and environmental testing
- F&DA, PCPA registration
- ECA notification

Manufacture: Chemical production

- worker health and safety
- plant operation
- controlled and accidental releases
- neighbourhood safety and contingency planning
- recycling; reuse; reduction of wastes

Transportation: Air, Water, Land Movement

- vehicle/container safety
- labelling/manifests

- operating procedures
- worker health/safety
- public health/safety
- accidental releases
- contingency planning

Distribution: Large numbers of small operators

- information transfer
- worker health and safety
- emergency response
- tracking systems for movement of chemicals

Use: Consumption of chemicals

- secondary manufacturing
- worker health/safety
- misuse
- consumer health/safety
- packaging, labelling
- product safety

Disposal: Ultimate discharge to air, water or land

- waste disposal practices
- community planning
- contamination of environment
- controlled and accidental releases

- NIMBY syndrome
- contingency plans
- worker health/safety

Evaluation and Assessment: Not a life stage but a means of monitoring the effectiveness of managing the life-cycle of chemicals

- state of the environment reports
  - ° exposure
  - ° loadings/sources
  - ° populations at risk
  - ° early warning systems
  - ° air and water guidelines/standards

- health and environmental action levels
- public expectations and values
- stakeholders policies

A schematic of how we use the life-cycle and some of the tools we have to manage the chemicals is shown in Figure 2.

Figure 3 pulls the whole life-cycle together. It shows that both existing and new chemicals can be managed throughout their life-cycle, as well as the fact that the stage can be managed. It also shows that there are common themes running through the life-cycle - worker health and safety, jurisdictional harmony. It

shows that the life-cycle can be broken down into manageable pieces that deliver the whole management approach. The final report contains 17 pages of actions that need to be implemented in the life-cycle in order to solve this issue. It is a long term project that we estimate may taken 10 years to implement.

How do we get there

- Adopt the approach for the management of chemicals.
- Review current activities.
- Implement actions to re-orient activities.
- Implement and communicate Workplace Hazardous Materials Information System, Bhopal Aftermath Review, Environmental Contaminants Act amendments.
- Take-on and deliver key pieces:
  - ° destruction facilities
  - ° existing chemicals testing
  - ° consumer information.
- Communication of the successes of achieving the management approach.

I believe, and my fellow task force colleagues agree, that we have rational and achievable solution to this issue. It is also important to realize that, using the process as we did with constant contact with our constituency, this represents the consensus of not just 15 people, but well over 300. People who helped us define the problem and define the solution.

Linus, in Charles Shultz's Peanuts has said that "no problem is too big that we can't run away from it". I think you will agree with me that this one is too big to run away from. It has to be faced and it has to be solved with the full participation of all who come in contact with chemicals. For everyone of us lives in this chemical society and benefits from it. But we each carry a responsibility to understand and care for the chemicals that maintain our society and the environment that maintains us. We all need and want a win/win solution to this issue. It's within our grasp, but we still have a lot of work before us to deliver it.

LIFE-CYCLE LINKAGES

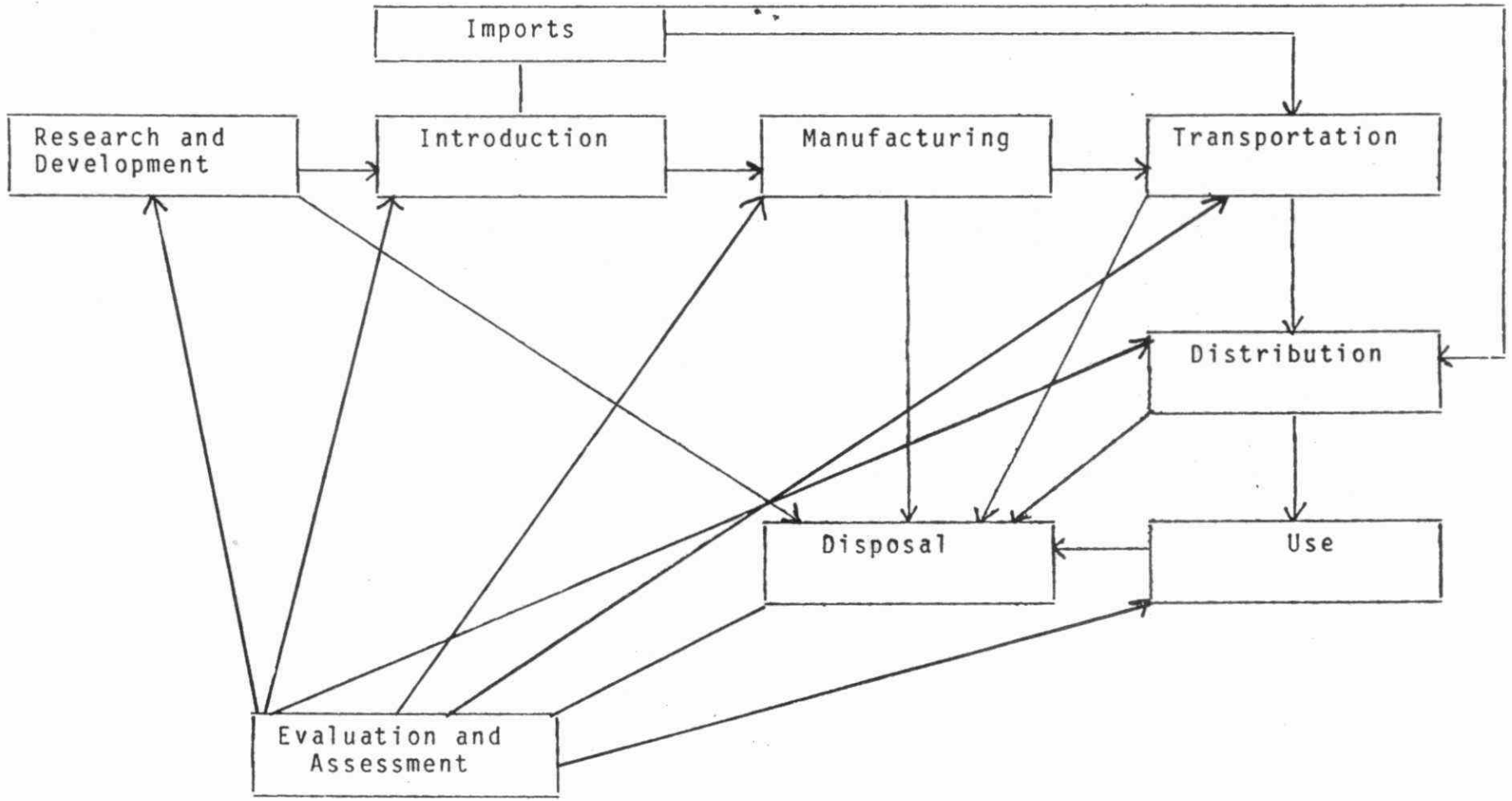


FIGURE 1

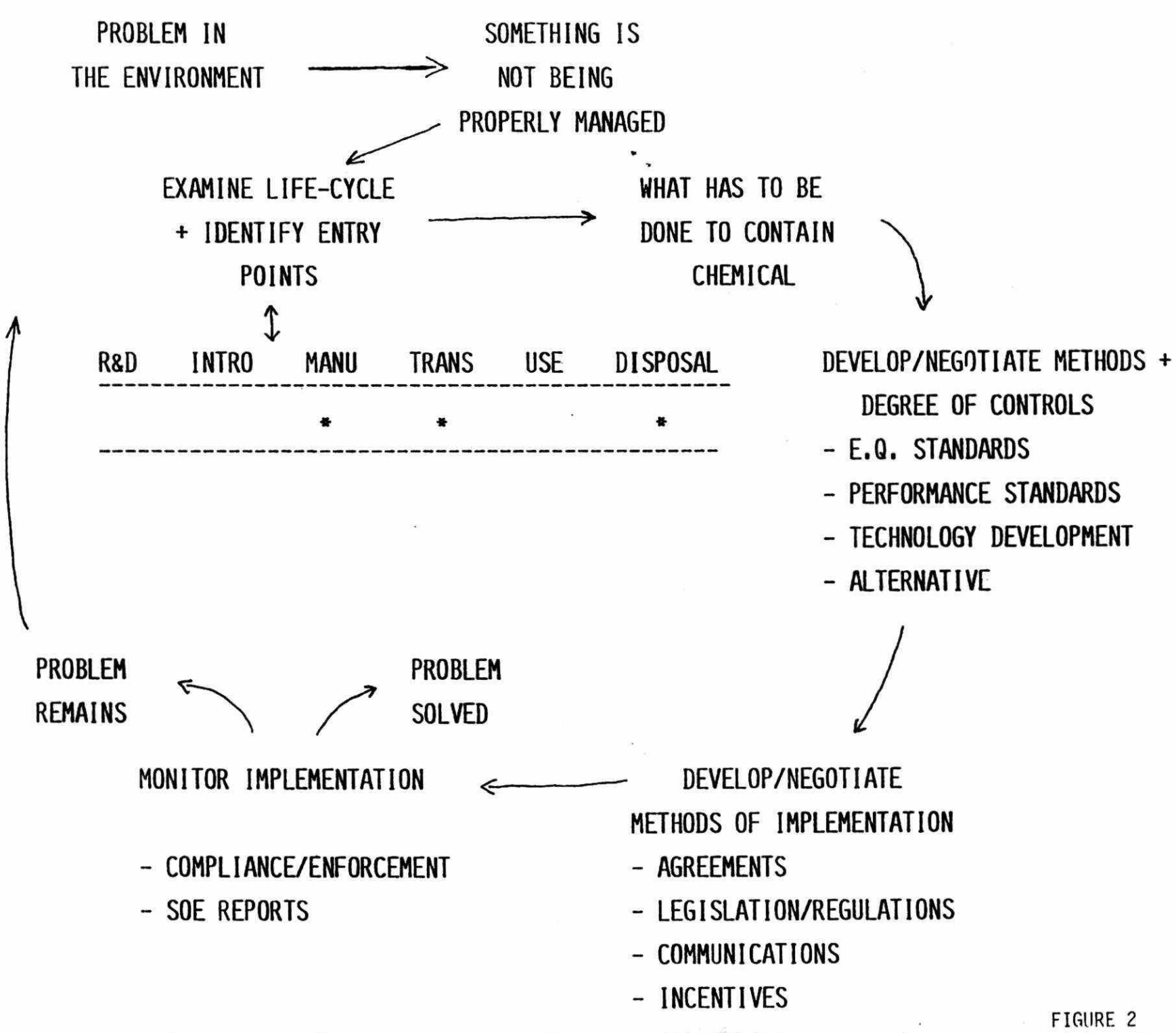

PROBLEM IN THE ENVIRONMENT
SOMETHING IS NOT BEING PROPERLY MANAGED
EXAMINE LIFE-CYCLE + IDENTIFY ENTRY POINTS
WHAT HAS TO BE DONE TO CONTAIN CHEMICAL
R&D INTRO MANU TRANS USE DISPOSAL
DEVELOP/NEGOTIATE METHODS + DEGREE OF CONTROLS
- E.Q. STANDARDS
- PERFORMANCE STANDARDS
- TECHNOLOGY DEVELOPMENT
- ALTERNATIVE
DEVELOP/NEGOTIATE METHODS OF IMPLEMENTATION
- AGREEMENTS
- LEGISLATION/REGULATIONS
- COMMUNICATIONS
- INCENTIVES
MONITOR IMPLEMENTATION
- COMPLIANCE/ENFORCEMENT
- SOE REPORTS
PROBLEM SOLVED
PROBLEM REMAINS

FIGURE 2

SCHEMATIC DIAGRAM - MANAGEMENT OF CHEMICALS

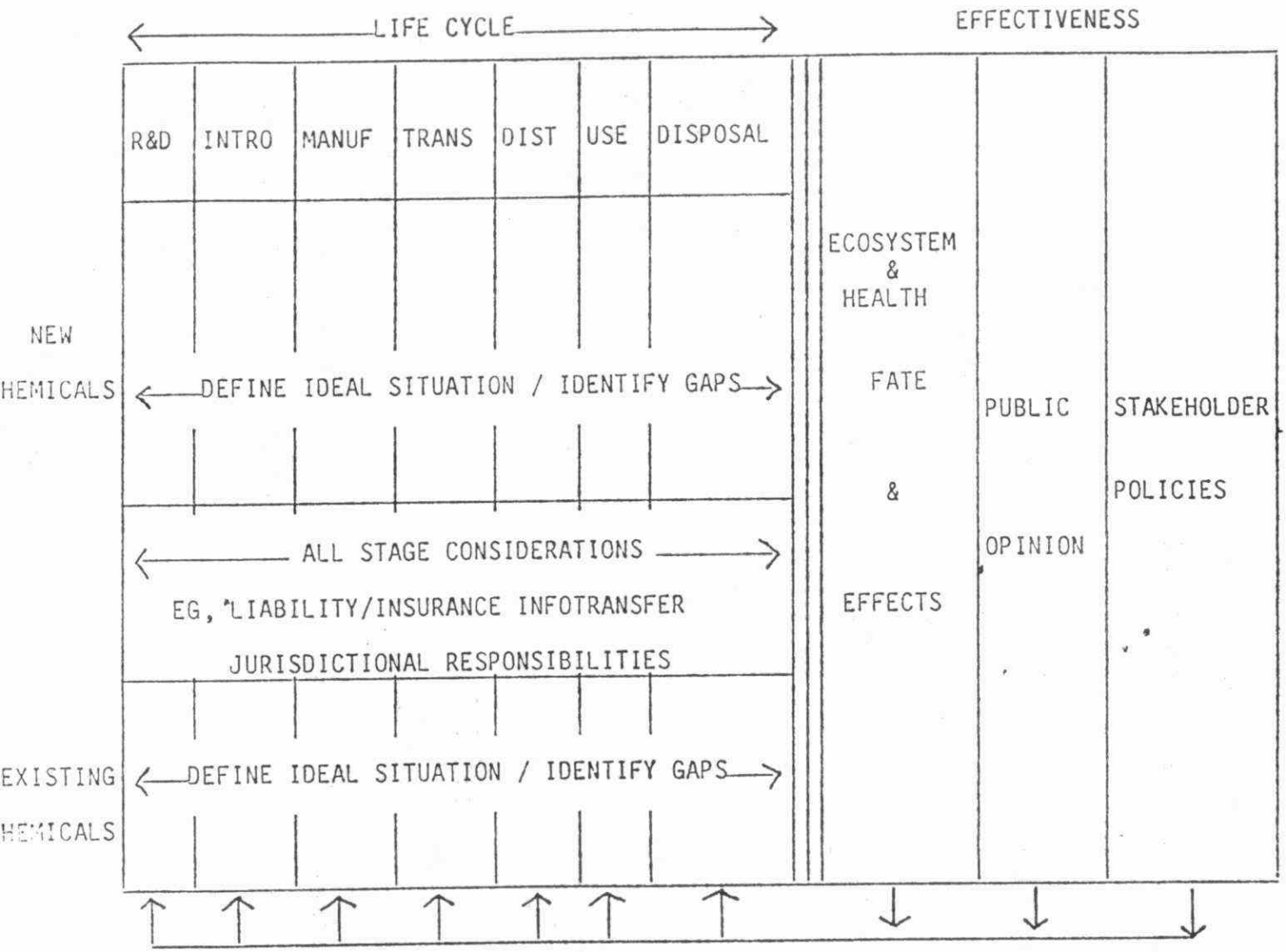


FIGURE 3

DEVELOPMENT OF MULTI-MEDIA ENVIRONMENTAL STANDARDS FOR DIOXINS AND DIBENZOFURANS

by B. Birmingham, B H. Thorpe and I. Wile,
Hazardous Contaminants Coordination Branch,
Environment Ontario, Toronto

ABSTRACT:

In recent years, there has been an increasing concern over the presence of dioxins and dibenzofurans in the environment. The most toxic form of dioxin, 2,3,7,8-T_4CDD has been found in Lake Ontario fish and in leachates from landfill sites in upper New York state. Both dioxins and dibenzofurans have been found in incinerator emissions, drinking water and most recently in some foods.

In response to these findings, a group of Ministry of Environment and Ministry of Labour experts was assembled in 1983 to prepare a criteria document for PCDDs and PCDFs which would provide the scientific basis for the development of environmental standards for all media. A panel of internationally renowned scientists was appointed to provide technical direction and peer review.

The criteria document which was published in 1985 uses a risk analysis approach with the toxicological assessment conducted in parallel with the assessment of environmental sources, fate and exposure pathways. Since in Ontario, the 75 PCDDs and 135 PCDFs occur as complex mixtures, a system of toxic equivalents was developed based on the toxic potency relationship between 2,3,7,8-T_4CDD and the other dioxins and dibenzofurans.

To protect human health, the document recommends a maximum allowable daily intake for total PCDDs and PCDFs equivalent to 10 picograms 2,3,7,8-T_4CDD per kilogram body weight from all routes of exposure. This number provides the basis for the development of multi-media environmental standards for dioxins and dibenzofurans.

Human beings are exposed to chemicals through three principal routes, namely, inhalation, ingestion and dermal contact. The major pathways which contribute to this exposure are air, food, drinking water and soil. At the present time, a federal-provincial working group is reviewing levels of dioxins and dibenzofurans contributed by these pathways for the purpose of apportioning the allowable daily intake based on their relative contributions to human exposure. This multi-media approach will ensure that the allowable daily intake from all routes of exposure is not exceeded.

INTRODUCTION

This paper is split into two parts - firstly, an overview of the development of the Scientific Criteria Document for Dioxins and Dibenzofurans, and secondly, a review of the multi-media standard setting process and how the Scientific Criteria Document is being used.

PART 1 Development of Scientific Criteria Document

Due to our location in Ontario close to the U.S. and sharing the Niagara River, the U.S. media have greatly sensitized us to the dioxin issue through the various events associated with the publicity of the Agent Orange issue, and the Times Beach soil contamination issue, and the Niagara River dump sites.

It now seems that some of the focus on the Niagara situation has been shifted to the St. Clair River system and the Rainy River and our food.

Problem

Because of public concern about the presence of dioxins in incinerator emissions, fish and the threat of leachate from the chemical landfills in Upper New York state, dioxins and furans were identified as a high priority for standard setting.

In 1983, a special branch was formed to coordinate the development of environmental standards using a multi-media approach.

Following are some highlights from the 536 page Scientific Criteria Document produced by this Branch as a part of the standard setting process. Copies of the complete document are available upon request from the authors.

Approach

The approach taken in the development of this particular document, was to initially form an internal expert committee, utilizing expert staff from the Ministry of the Environment (Table 1), with human health expertise obtained from the Ministry of Labour.

The task of this Internal Committee was to review existing guidelines for these substances, to review current literature and our own monitoring data for dioxins and furans in the Province, and to develop the Scientific Criteria Document with human health considerations in mind, since clearly, the receptor of interest was human.

To assist us and to provide scientific direction in the production of this document, the Minister appointed a panel of international scientists to the Ontario Scientific Advisory Committee on Dioxins and Furans (Table 2).

TABLE 1: INTERNAL EXPERT COMMITTEE

Member	Ministries	Expertise
Dr. B. Birmingham (Chairman)	Environment	Environmental Toxicology
Dr. D. Harding	Labour	Human Health
Mr. R. Pearson	Environment	Phytotoxicology
Dr. D. Rokosh	Environment	Mutagenesis
Dr. A. Szakolcai	Environment	Environmental Chemistry
Ms H. Tosine/ Dr. R. Clement	Environment	Analytical chemistry
Mr. D. Wells	Environment	Aquatic Toxicology
Mr. W. Smithies	Environment	Policy
Ms B. Hanna Thorpe (Secretary)	Environment	Environmental Assessment

TABLE 2: ONTARIO SCIENTIFIC ADVISORY COMMITTEE ON DIOXINS AND FURANS

Prof. O. Hutzinger	University of Bayreuth, Germany
Prof. H. Plaa	Universite de Montreal
Prof. S. Safe	Texas A & M University
Dr. E.Y. Spencer (Chairman)	University of Western Ontario
Dr. B. Birmingham (Secretary)	Ministry of the Environment

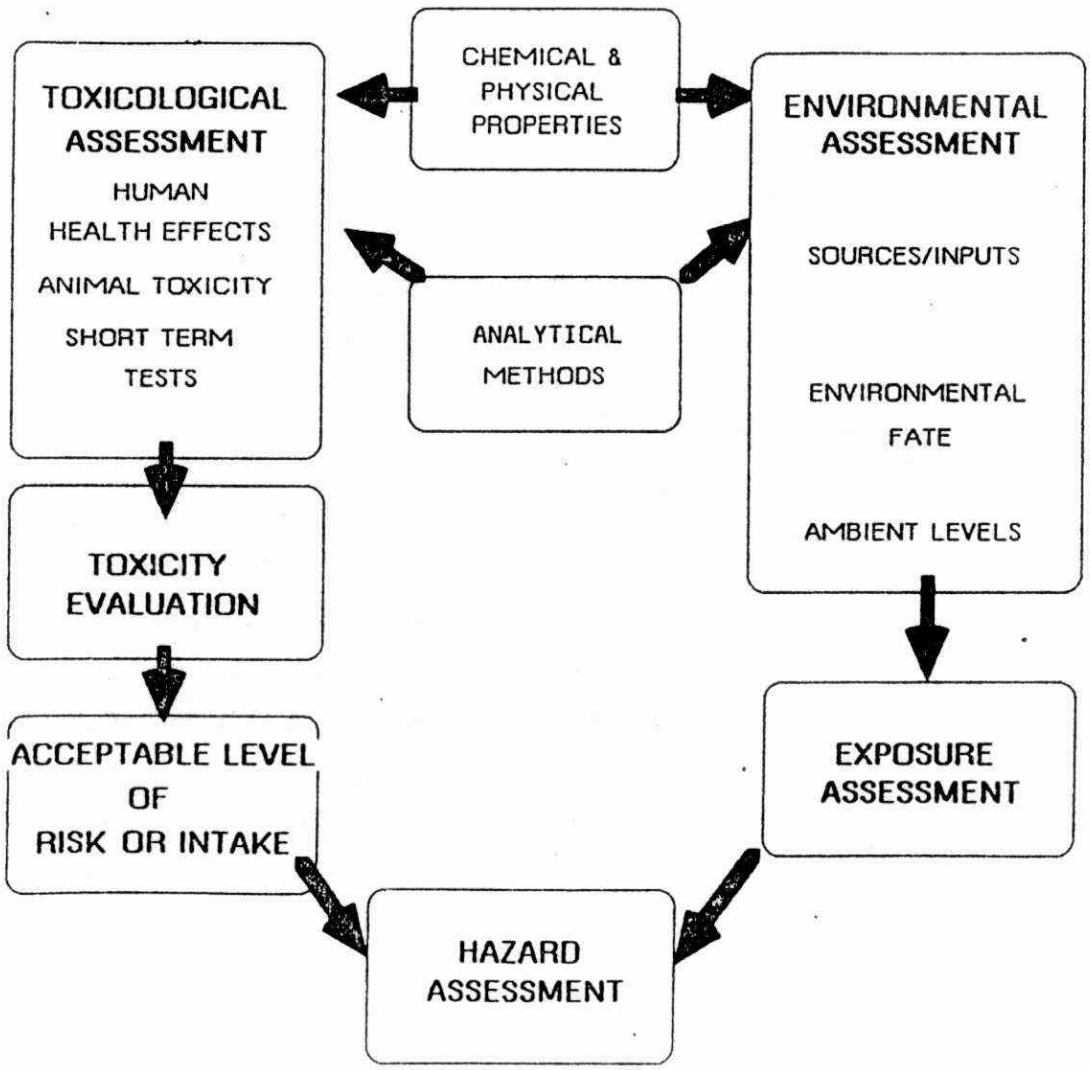
These are international experts, external to our government, whose job it was to ensure a high quality of scientific direction and peer-review of the material produced by the internal committee.

Risk Analysis

We have used what we call the risk analysis approach. This terminology basically defines risk analysis as assessing the toxicological hazard and the exposure hazard separately and then comparing them to come up with an estimate of the toxicological risk (Figure 1). In our approach, the toxicological assessment was conducted in parallel with the environmental assessment.

The basis for the proposed umbrella allowable daily intake was the toxicological data. Basically, we wanted to determine if there was an acceptable level of exposure or acceptable level of risk based on the review of the toxicity data. The exposure assessment is what tells us whether a risk exists or not.

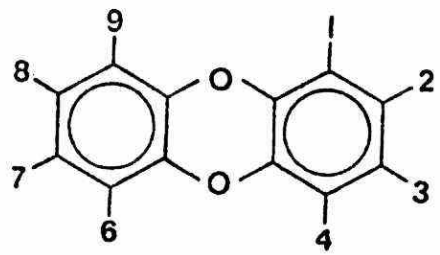
FIGURE 1: RISK ANALYSIS



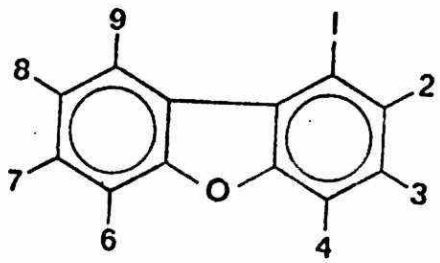
Our aim was to produce an umbrella number for total exposure including diet.

Dioxins and furans have a triple-ring structure, consisting of 2 benzene rings connected to the other via 1 or 2 oxygen atoms (Figure 2).

FIGURE 2:



dibenzo-p-dioxin



dibenzofuran

There are 75 dioxin isomers and 135 furan isomers. The properties of these isomers are related to the number and position of the chlorine atoms attached to the benzene rings.

In most toxic forms of PCDDs and PCDFs are those containing 4-6 chlorine atoms with 4 of the chlorine atoms in the lateral positions, i.e. the 2,3,7 and 8 positions.

At the present time, about a dozen of these 2,3,7,8-substituted isomers, in the tetra-, penta- and hexa-chlorinated isomer groups have been identified as being highly toxic with toxicities only 1/10 to 1/100 that of 2,3,7,8-T_4CDD. These isomers are sometimes referred to as the "dirty dozen".

Toxicological Assessment

As indicated, there are 210 dioxin and furan isomers, however, chronic toxicity data only exists for 3 of them. While we reviewed all toxicity information that we could find on all dioxins and furans, the focus of our review was on the 2,3,7,8-T_4CDD isomer, since this is clearly the isomer with the greatest amount of toxicological data.

In our review of 2,3,7,8-T_4CDD we reviewed all the data on the acute responses such as LD_{50}, enzyme induction, immunotoxicity, short term mutagenicity tests and environmental toxicity tests. We also reviewed chronic responses such as cancer bioassays and reproductive studies in animals. We also looked at the human data and the epidemiological data that was available.

The purpose of our review was to identify reliable, well-validated data; to determine the most sensitive end-point and the most appropriate species if human data was unavailable; and to derive a dose-response relationship from which an appropriate level of protection can be chosen.

TABLE 3: IN VIVO TOXICOLOGICAL EFFECTS OF 2,3,7,8-T_4CDD ON MAMMALIAN SPECIES

SPECIES	DOSE	EFFECT
Acute Responses	(ug/kg)	
Hamster	1157 - 5051	LD_{50}
Mouse	114 - 284	LD_{50}
Rabbit	115	LD_{50}
Monkey	50 - 70	LD_{50}
Guinea Pig	0.6 - 2.0	LD_{50}
Rat/Mouse/Rabbit	0.1	NOEL-Reproductive Effects
Rabbit	0.01 - 0.1	LEL-Keratinization
Mouse	(0.016)	LEL-Immune Suppression
Rat	0.002	LEL-AHH Induction
Chronic Responses	(ug/kg/day)	
Rat	0.007	LEL-Tumour Production
Monkey	0.002	LEL-Reproductive Effects
Mouse	0.0017	LEL-Tumour Production
Rat	0.001	NOEL-Reproductive Effects (3-generation study)
Rat	0.001	NOEL-Tumour Production

As can be seen in Table 3, there is quite a variation in the acute toxicity of 2,3,7,8-T_4CDD. However, at the low end of the range of doses administered, we can see evidence of no observed effect levels. This is also true for chronic responses and gives us an idea of where we should be extrapolating from in order to estimate safe levels of exposure.

A problem that we ran into was related to the fact that 2,3,7,8-T_4CDD is often not detectable in the mixtures analysed in our Province and that there is a very wide range of toxicities amongst the different isomers. Clearly, to assume that all other dioxins and furans in such mixtures are equally toxic to 2,3,7,8-T_4CDD is no longer scientifically justifiable or necessary.

Consequently, we reviewed all the acute and sub-chronic data that we could lay our hands on to construct a matrix of all the known effects of the other dioxins and furans. Also, we took into consideration, the fact that there seems to be a strong structurally-related basis to the activity of these compounds, with substitution in the 2,3,7,8 positions being involved, as mentioned previously.

Since it is clear that it will take decades to accumulate sufficient chronic toxicological data to set a standard for most of the other dioxins and furans that we find in the environment, we

decided to utilize these apparent toxic potency relationships as a basis for proceeding with some sort of interim control strategy for dioxins and furans.

The toxicity ranking scheme that we came up with is shown in Table 4. The factors for dioxins are in the top part of the table followed by the factors for furans. This toxic equivalent ranking scheme involves a number of conservative assumptions. One is that we consider that the effects of all the dioxins and furans in the mixtures are additive.

The other assumption is that the toxic equivalent factor for each group of dioxins and furans is based on the most toxic member of the group. That is the ones with chlorine atoms in the 2,3,7 and 8 positions.

TABLE 4: ESTIMATED RELATIVE TOXICITY OF PCDD AND PCDF ISOMERS TO 2,3,7,8-T_4CDD

ISOMER GROUP	TOXICITY FACTOR RELATIVE TO 2,3,7,8-T_4CDD
DD	Non-Toxic
M_1CDD	0.0001
D_2CDD	0.001
T_3CDD	0.01
T_4CDD*	0.01
P_5CDD	0.1
H_6CCC	0.1
H_7CDD	0.01
O_8CDD	0.0001
DF	Non-Toxic
M_1CDF	0.0001
D_2CDF	0.0001
T_3CDF	0.01
T_4CDF	0.5
P_5CDF	0.5
H_6CDF	0.1
H_7CDF	0.01
O_8CDF	0.0001

* excluding 2,3,7,8-T_4CDD

This gives a very large implicit safety factor since in most cases, the most toxic fraction of each isomer group is usually less than 50% and often only represents 1/10 to 1/100 of the analysed content.

Of course we recognize that as new scientific information becomes available, this interim approach to estimating the toxicity of these substances will, of course, have to be modified.

As can be seen, the factors demonstrate the wide range of toxicities involved.

Rationale for the Proposed Allowable Daily Intake

The following is a review of the most important points in our toxicological overview of the 2,3,7,8-T_4CDD data which forms the basis of our proposed allowable daily intake summarized in Table 5.

1) The acute toxicity data indicates extreme toxicity with a wide range of sensitivities in different species;
2) The mutagenicity tests are in general negative or inconclusive;
3) A direct mode of action involving direct binding to or direct action on chromosomes or the DNA has not been indicated;
4) 2,3,7,8-T_4CDD is teratogenic and fetotoxic but no effect levels (NOEL) were observed in these tests;

TABLE 5: RATIONALE FOR PCDD AND PCDF STANDARD

TOXICOLOGICAL OVERVIEW (Standard based on 2,3,7,8-T_4CDD)	
Acute Toxicity Tests	- extremely toxic (wide range of sensitivity)
Mutagenicity Tests	- negative (inconclusive) - indirect mode of action
Animal Reproduction Tests	- positive (NOEL indicated
Animal Cancer Tests	- positive (NOEL indicated - indirect non-genetic mode of action
Human Health Effects	
Short term effect	- chloracne (high exposure
Chronic effects (cancer or reproduction)	
	- negative (inconclusive)
TOXIC CRITERION FOR STANDARD (Most sensitive effect)	
Incidence of liver tumours in female rats (Kociba et al, 1978) - well designed, well validated study - NOEL (0.001 ug 2,3,7,8-T_4CDD/kg body weight/day)	
ASSUMPTIONS	
- threshold for liver tumours exists (NOEL) - humans are no more sensitive than rodents - 100-fold safety factor will provide adequate margin on safety - toxicity of other PCDDs and PCDFs can be prorated to that of 2,3,7,8-T_4CDD using appropriate factors	
RECOMMENDED MAXIMUM ALLOWABLE DAILY INTAKE	
10 pg 2,3,7,8-T_4CDD or its equivalent/kg body weight	

5) The animal cancer tests with rodents are positive, however, a no observed effect level is also indicated;

6) In terms of the human health effects, the major acute effect is that of chloracne, generally only observed in people who are occupationally or accidentally exposed to relatively high concentrations;

7) Evidence for chronic effects of dioxins on the incidence of cancer or reproductive problems in the human population is negative or at best, inconclusive. Dioxins always occur as contaminants of other chemicals, and currently we are unable to pinpoint effects in the human population that can be specifically nailed down as being caused by only the dioxin or furan component;

8) The toxic criterion for our standard was the study of Kociba et al, 1978. This study is well designed and well validated. The data indicates a no effect level. As far as we are aware, there are no other chronic toxicological effects that occur at lower doses, i.e. that are more sensitive, than these cancer bioassays using rodents.

9) Based on what we know about the activity of dioxins in mutagenic tests, and their general lack of evidence for the direct action on DNA or chromosomes, it was the conclusion of our committees that a threshold for tumours exist in the rodents examined, that humans are no more sensitive

than rodents and that a reasonable doubt exists that 2,3,7,8-T_4CDD will cause cancer in humans at levels below those which have no effect in animals. Consequently, a 100-fold explicit safety factor would provide an adequate margin of safety.

The committee also decided that the toxicity of other dioxins and furans could be pro-rated to that of 2,3,7,8-T_4CDD using appropriate factors.

A basic assumption behind our deliberation was that Ontario citizens are generally exposed to dioxins and furans other than 2,3,7,8-T_4CDD. Therefore, the proposed umbrella maximum allowable daily intake of total PCDDs and PCDFs we have derived is the equivalent of 10 pg (picogram) of 2,3,7,8-T_4CDD/kilogram body weight/day.

It should be pointed out that this number is an annual average and that the daily intake may be lower or higher than 10 pg/kg/day and still be within the guideline. However, averaged over a year the intake should not exceed this daily intake number.

Environmental Assessment

Our estimates of the quantities of dioxins and furans entering the Ontario environment are based on our own monitoring data, and where this

does not exist, we have extrapolated from Canadian or International data sets. One area for which we are currently developing sampling methodologies is ambient air. However, we had to derive estimates of ambient air concentrations based on standard dispersion models.

Table 6 summarizes the findings of the environmental assessment. The sources that we have determined to be of importance are:

1) The use of chemical products contaminated with dioxins and furans. These are principally chlorinated phenols such as pentachlorophenol where the bulk of the dioxins and furans from this source are the less toxic hepta- and octa-chlorinated forms. We have estimated the total dioxin/furan quantity input to the province to be on the order of abut 500 kg per year. There is no 2,3,7,8-T_4CDD in these chemical products now. So that when we apply our toxic equivalent factors, the equivalent toxicity of this quantity of dioxins and furans is quite a bit lower on the order of about 4 kg per year.
2) The second major source is combustion. We have divided this into two major categories; the first category is that of municipal refuse and sewage sludge incineration. These are processes over which we can exert a fair amount of control. The other category is all other combustion processes.

TABLE 6: ENVIRONMENTAL ASSESSMENT (ESTIMATED QUANTITIES OF PCDDS AND PCDFS ENTERING THE ONTARIO ENVIRONMENT)

SOURCE	ESTIMATED CURRENT TOTAL PCDD & PCDF	QUANTITY (KG/YR) 2,3,7,8-T_4CDD TOXIC EQUIVALENTS
1. CHEMICAL PRODUCTS (No 2,3,7,8-T_4CDD now)		
A. Phenoxy herbicides		
B. Chlorinated Phenols		
C. Polychlorinated Biphenyls	> 500	> 4
D. Chemical Wastes from A, B and C		
E. Commercial/ Domestic Products		
2. COMBUSTION		
A. Municipal Refuse/ Sewage Sludge	29 - 37	8 - 10
B. All other Combustion Sources	100 - 200	20 - 50
3. TRANSBOUNDARY		
A. Airborne	Unknown	Unknown
B. Waterborne	2 - 20	<2 - 20
4. SEWAGE	Unknown	Unknown

We have reasonably accurate estimates of what is produced by the incineration of refuse and sludge, and since a percentage of the isomers in these emissions are 2,3,7,8 substituted, the toxicological quantity of these substances being emitted is comparable with that from all chemical products. Our estimates for the other combustion sources are of necessity, a lot less precise.

Exposure Assessment

Since dioxins and furans are persistent environmental contaminants that have penetrated most media, the assessment of exposure becomes quite complex and by its nature, a multi-media situation. Using ambient level data estimated from the environmental assessment, we modelled exposure via inhalation, ingestion, and dermal contact pathways. Fairly standard models based on the surface area and weight of the body, the volume of air inhaled, the quantity of food and the quantity of water ingested were used.

The conclusions of the exposure assessment which of necessity was a preliminary one, indicated that the major routes of exposure appear to be as follows: The primary one of concern in Ontario is that of ambient air in the vicinity of incineration sources. The next important exposure pathway is that of diet. It is clear that the higher chlorinated isomers such as hepta- and octa-chlorinated dioxins are being found in

some food basket items. 2,3,7,8-T_4CDD has also been found in some sport fish from the Great Lakes and the Rainy River.

The third source that could lead to dioxins and furans coming into the province, is what we call transboundary. This includes long range atmospheric transport of dioxins and furans on air particulate matter, and, waterborne dioxins and furans. We have no estimates of air transport quantities. The principal transboundary source of concern to this Province is through the Niagara River. Federal estimates released about two years ago, suggest that somewhere in the range of 2-20 kg per year of dioxins and furans may be flowing into Lake Ontario via the Niagara River. At this time, it is not clear what the toxic equivalent of this material is.

Another source that we considered was that of sewage. Sewage is the end point of much human and industrial activity, and there is evidence that low levels of dioxins and furans are found in this material. Our reason for being concerned about this material is the very large quantity which is produced by municipalities every year. The recent finding of dioxins in some pulp and paper sludges has accelerated Ministry research into this situation.

The other two pathways of exposure are considerably less important than the inhalation

and dietary pathways of exposure. Soil may be contaminated by deposition of airborne dioxins and furans from incineration activities and our concern was mainly with young children playing in soil who might transfer soil to their mouths during play activity.

The surface water exposure pathway is minor and only applies to people dependent on untreated tapwater near a source of pollution. So far only trace amounts of the octa-chlorinated dioxin have bene detected in treated tapwater at the parts-per-quadrillion detection level. Given the toxic equivalence factor for O_8CDD of 0.0001, this is not a significant source.

Conclusion

An umbrella ADI was developed, based on risk analysis. Using a multi-media approach we have identified major sources and identified problem exposure pathways.

Now having developed an umbrella number, our next step is to partition this into individual standards or guidelines for ambient air, water and waste, in such a manner that these guidelines and standards together, do not exceed the overall intake of the toxic equivalent of 10 pg 2,3,7,8-T_4CDD kg/day.

PART 2 Development of Multi-Media Standards

After completion of the Scientific Criteria Document, the Ministry decided that Environment Canada and Health & Welfare Canada should be involved in developing environmental standards using the scientific criteria document. This decision was made because of:

1) The obvious advantages in having uniform national objectives for these contaminants.
2) The multiple jurisdictions who will be involved in control of dioxins and dibenzofurans from various sources, e.g. Health & Welfare Canada has the primary responsibility for regulating food.

After some discussion, it was decided that the Federal/Provincial Advisory Committee on Environmental and Occupational Health, which has membership from all Provinces and the Federal Government, would be the most appropriate existing mechanism. One of the important standing committees reporting to it, is the group that develops the Canadian Drinking Water objectives.

The Advisory Committee considered Ontario's request and decided to establish an Ad Hoc Committee. This committee is chaired by Health & Welfare Canada, with representatives from Federal and Provincial Agencies.

The Ad Hoc Committee has been given two tasks. The first is to prepare a paper on guiding principles for allocating total allowable intake figures using a multi-media approach considering all exposure routes and pathways.

Secondly, to apply the general approach to dioxins and dibenzofurans using the allowable daily intake figure developed by the Ontario Ministry of the Environment in its scientific criteria document as the starting point. The report of the Ad Hoc committee to the parent advisory committee is expected to be completed in August of 1986.

Subsequently, specific regulatory control numbers can be developed.

Allocation of the Allowable Daily Intake

The allowable daily intake is allocated to the various exposure pathways so that the specific environmental standards can be developed. It is important to emphasize that there is no rigid formula; rather each chemical or family of chemicals should be assessed individually.

Not only the scientific information but also socio-economic and technical considerations become important especially where current levels of exposure from all pathways approaches or exceeds the allowable total intake figure.

Figure 3 illustrates the way that humans are exposed to an environmental contaminant. In Part 1 of this paper, we explained how the exposure assessment was carried out in developing the Scientific Criteria Document for dioxins and dibenzofurans. Of particular importance to the allocation exercise is information on current ambient levels via the pathways leading to the three routes of human exposure.

For example, human beings can ingest a contaminant through air, food, consumer products, drinking water and in the case of children, even from soil.

In Figure 4, which shows the process for the development of regulatory controls, the direction of the arrows has changed from that in Figure 3. In this process, we are going from the umbrella total allowable intake, to allocating a percentage of this intake to each route of exposure and ultimately to the development of appropriate controls shown at the bottom.

In developing the allowable daily intake, you may determine that the toxic end points associated with the major routes of exposure are different.

Once the allowable intake for a specific end point has been set, this value should be allocated only to those routes of exposure which are thought to lead to the specific end point.

HUMAN EXPOSURE TO ENVIRONMENTAL CONTAMINANTS

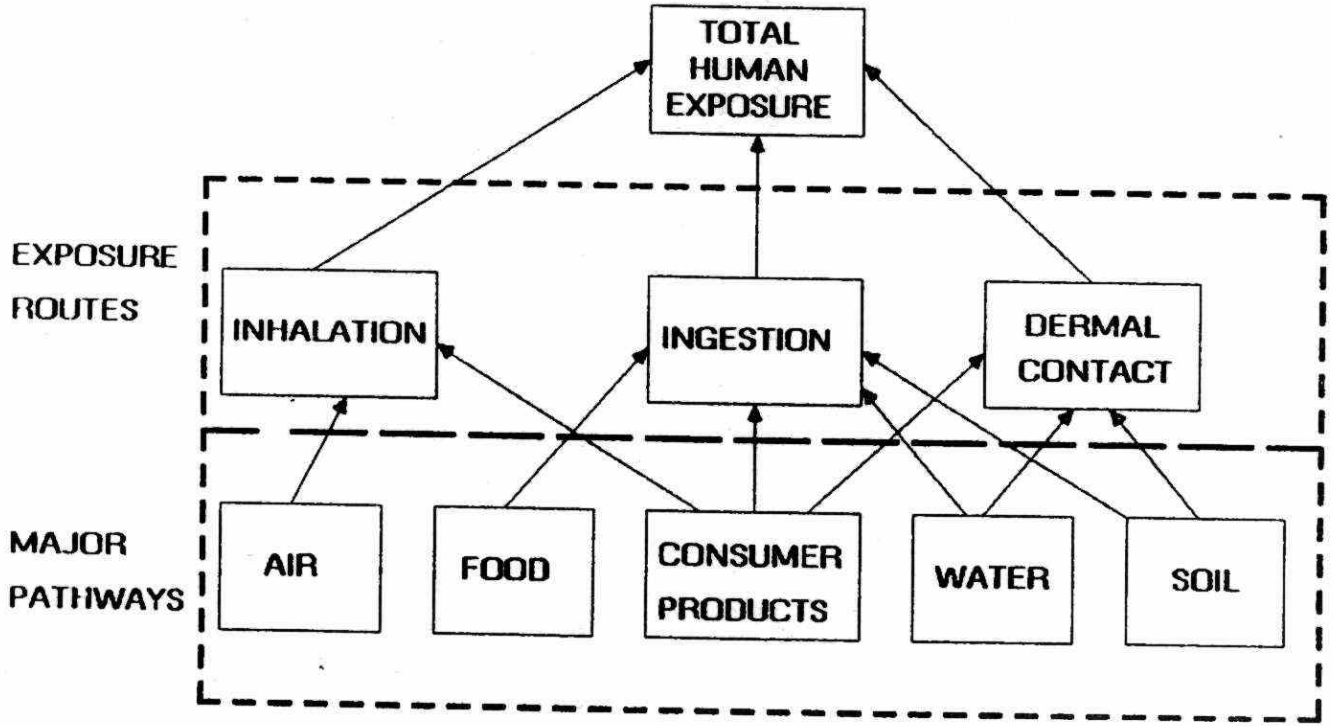


FIGURE 3:

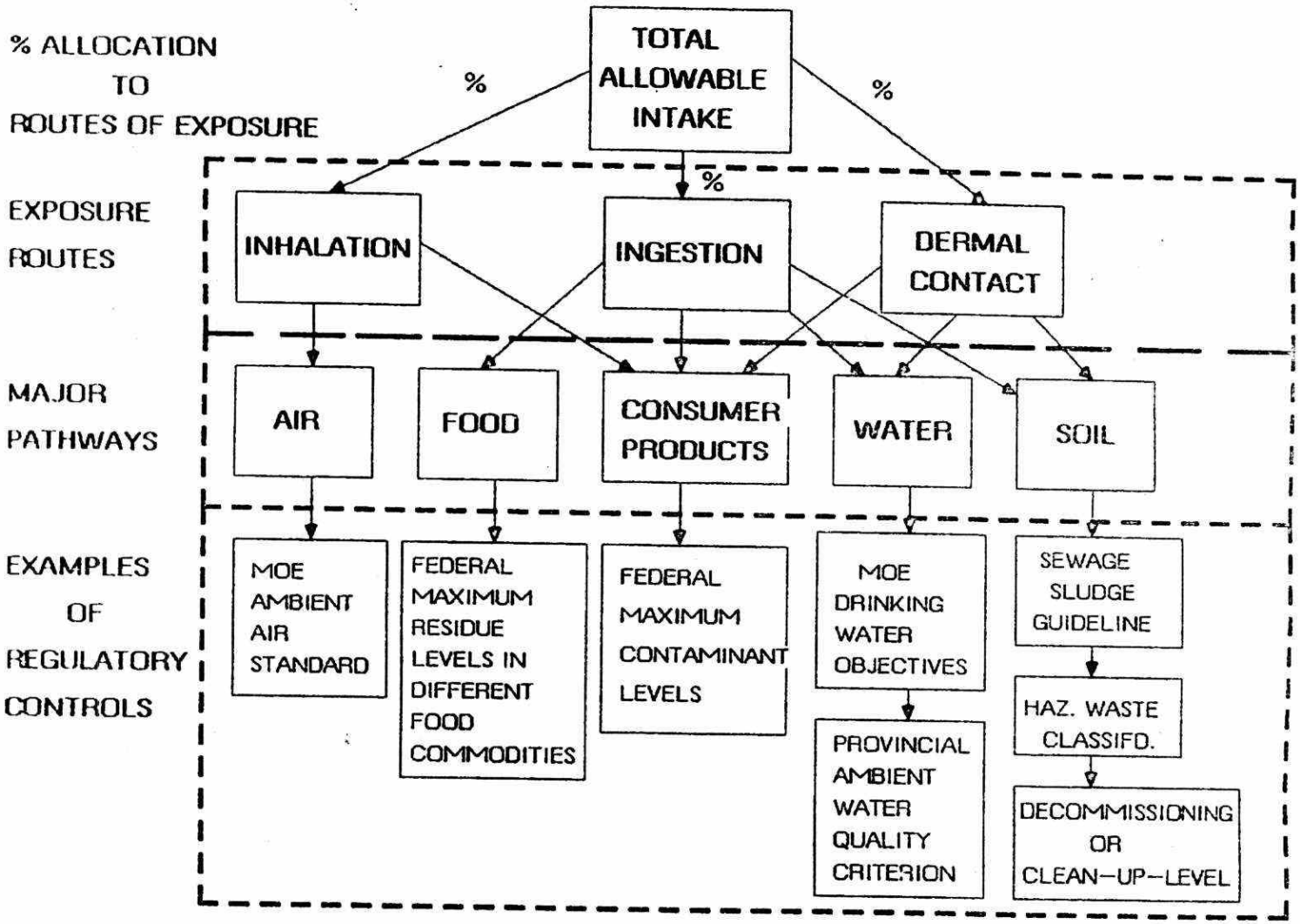


FIGURE 4: DEVELOPING REGULATORY CONTROL LEVELS

In the case of dioxins and dibenzofurans, there is a single allowable intake figure because it is felt that inhalation, ingestion or dermal contact all lead to the same systemic effects.

Allocation to the pathways should be based primarily on relative contributions via each pathway. This will involve both consideration of current exposure levels, based on ambient measurements or estimates, and the proportion absorbed. What this means is that not all of the contaminant which is present in air or food or water is necessarily absorbed by the person who is exposed.

In the case of dioxins and dibenzofurans the Ministry of the Environment has been very active in monitoring for these compounds in a number of environmental pathways,.

The members of the Ad Hoc Committee feel that the data which is available from both Ontario and Federal monitoring, although not complete in every respect, is adequate to allow a recommendation on the allocation of the ADI to the major exposure pathways.

In order to calculate what the maximum allowable ambient concentrations of dioxins and dibenzofurans should be in the various pathways, it is necessary to estimate exposure. This is based on estimating the average amount of air we

breathe, or the amount of different foods we eat, multiplied by the concentration of dioxins and furans found in each of these media. The relative contribution of each pathway then forms the basis for allocation of the ADI and subsequent development of standards and guidelines.

Examples of the kind of regulatory controls that might then be developed are; ambient air standards or in the case of soil, you might develop sludge application guidelines, de-commissioning or clean-up levels, or a hazardous waste classification.

As indicated earlier, decisions on the apportioning of the allowable intake amongst the various exposure pathways may have to consider economic and technical feasibility of control of the various sources.

Where exposure to a contaminant from one pathway is more amenable to control than from another, the apportionment of the allowable intake should take this into consideration. And this is especially true in instances where current overall exposure to a contaminant may approach or exceed the allowable exposure levels. This does not appear to be the case with dioxins and dibenzofurans.

In summary then, the current activity of the Ad Hoc Committee is to recommend how the total allowable intake figure for dioxins and dibenzofurans should be apportioned among the major pathways. It is not part of the mandate of this group to develop the specific regulatory controls.

General Comments on the Multi-Media Approach

Traditionally, guidelines have been developed on a medium-by-medium basis without always giving due consideration to multiple routes of exposure. An important exception to this has been the approach usually used in setting drinking water objectives, where some percentage of an allowable intake is used. But this approach is not generally based on a rigorous scientific evaluation of all routes of exposure.

The single medium approach in many instances is a result of compartmentalized legislation and governmental organization.

In general, human beings are the most important receptor for multi-media contaminants because of their exposure via a number of routes, and because of their place at the top of the food chain.

Standards to protect human health can be based on the effects of either short-term, high-level, or long-term, low-level exposures. Short-term, high-level exposures are not likely to occur simultaneously through multiple media.

Generally, the multi-media approach is applicable to long-term exposures to chemicals which are ubiquitous because they persist, are discharged continually, or have a tendency to bioaccumulate.

Examples of such contaminants are persistent organics such as dioxins and dibenzofurans, and PCBS; persistent metals such as arsenic, cadmium and lead; or ubiquitous contaminants such as polynuclear aromatic hydrocarbons.

The multi-media approach to standard setting is a process by which environmental standards are developed in an integrated manner. Its purpose is to ensure that an acceptable level of exposure from all environmental sources is not exceeded.

This approach to the development of standards provides for more consistent management of chemicals. Such an approach to standard setting may involve multi-agency participation and therefore initially be resource intensive. However, reorganization of regulatory agencies is not necessary. Rather, the approach requires coordination and involvement of a team of

multi-disciplinary experts. Thus it takes longer to develop standards in this way. However it results in consistent decision-making on risk.

The implementation of a strategy to control a contaminant may require the development of specific standards or regulations for controlling the level of a contaminant from various sources. The different agencies which have mandates to develop such standards and guidelines, should do so recognizing a coordinated allocation of allowable exposure levels. In addition, the approach will avoid duplication of effort.

The Ontario Ministry of the Environment is a pioneer in the multi-media approach to developing environmental standards. The Scientific Criteria Document that we have produced for dioxins and dibenzofurans, has been recognized by the Canadian Government and other jurisdictions as a major achievement and break-through. A number of other jurisdictions in the world are also considering the multi-media approach.

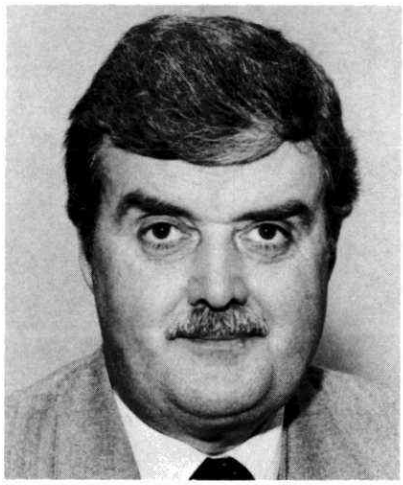
For instance, in October, the U.S. EPA is hosting a workshop on behalf of the North Atlantic Treaty Organization Chemical Challenges to Modern Society, on multi-media approaches to the assessment and management of hazardous environmental contaminants. Speakers are being

invited from the U.S., Japan, Germany and Italy and other member countries, to discuss real experiences with various multi-media approaches to share information and to develop new strategies. We have been invited to participate.

In summary, the benefits of the multi-media approach to standard setting include assurance:

1) That total exposure is kept below maximum allowable intake levels.
2) That consistent risk evaluations and decisions on acceptable risk are made for the same contaminant from different exposure pathways.
3) That a single comprehensive scientific evaluation is made which provides the best technical advice and avoids duplication of effort.

Although initially labour intensive, and sometimes difficult to arrange because of organizational obstacles, the product provides the basis for an integrated and comprehensive management of environmental chemicals that treats all sources equitably.



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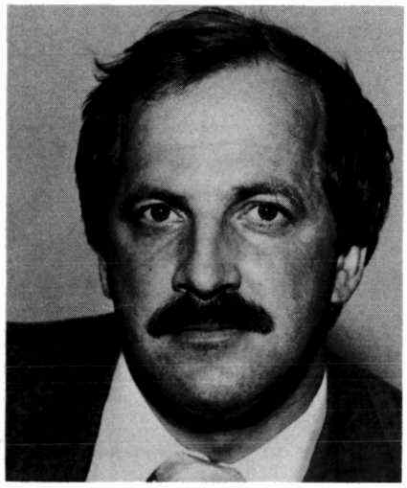

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THE NATIONAL INCINERATOR TESTING AND EVALUATION PROGRAM: AN ASSESSMENT OF PILOT SCALE EMISSION CONTROL

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SUMMARY

The National Incinerator Testing & Evaluation Program (NITEP), developed by Environment Canada, established as one of its objectives the assessment of air pollution control technologies suitable for the control of emissions from municipal energy-from-waste facilities. This assessment examined the removal of a wide range of organic and inorganic substances for a variety of operating conditions. The study utilized two lime based gas scrubbing devices developed by Flakt Canada, in combination with a fabric filter. The results demonstrate an ability to remove dioxins, furans, other organics, metals and acid gases to a very significant degree. Temperature was a most important parameter affecting removal efficiency of most pollutants examined.

Introduction

The literature has identified substantial variations in the quality of air emissions from municipal energy-from waste facilities. It is evident that modern well operated units tend to have lower emissions than older and less effectively operated facilities. Modern air emission control technologies play an important role in reducing emissions; however, there is very little data, particularly with respect to dioxins and other organic compounds, which quantify control capabilities.

Under the National Incinerator Testing & Evaluation Program (NITEP), Environment Canada, in co-operation with Flakt Canada Ltd., established an extensive test program to conclusively evaluate the capability of two control systems to remove particulate, acid gases, heavy metals, dioxins, furans and other organic compounds. In addition, the optimum operating conditions to minimize these contaminants were also of great interest.

In order to undertake this work, Flakt Canada Ltd. constructed a large scale pilot plant facility at the energy-from-waste plant owned by the Quebec Urban Community (CUQ) and operated by Montenay Inc. in Quebec City.

Incinerator Description

The CUQ incinerator is a mass burning design, developed in the early 1970's to burn as-received refuse in a water wall furnace. There are four incinerators, each rated at 227 tonnes per day with a common refuse storage

pit and stack. As illustrated in Figure 1, each incinerator consists of a vibrating feeder-hopper, feed chute, drying/burning/burn-out grates (Von-Roll design), refractory lined burning zone, water-walled, partially lined upper burning zone, a waste heat recovery boiler with superheater and economizer (Dominion Bridge), a two field electrostatic precipitator, an induced draft fan and a wet ash quench/removal system.

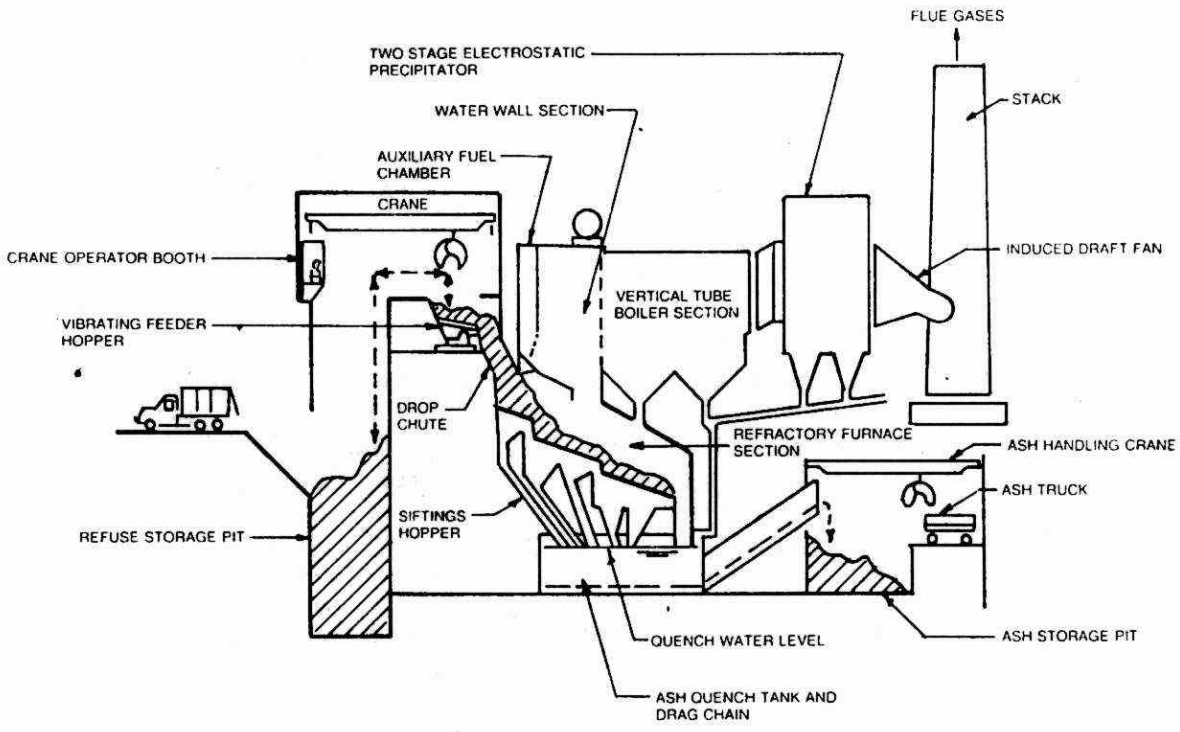


FIGURE 1
QUEBEC INCINERATOR
SCHEMATIC CROSS-SECTION

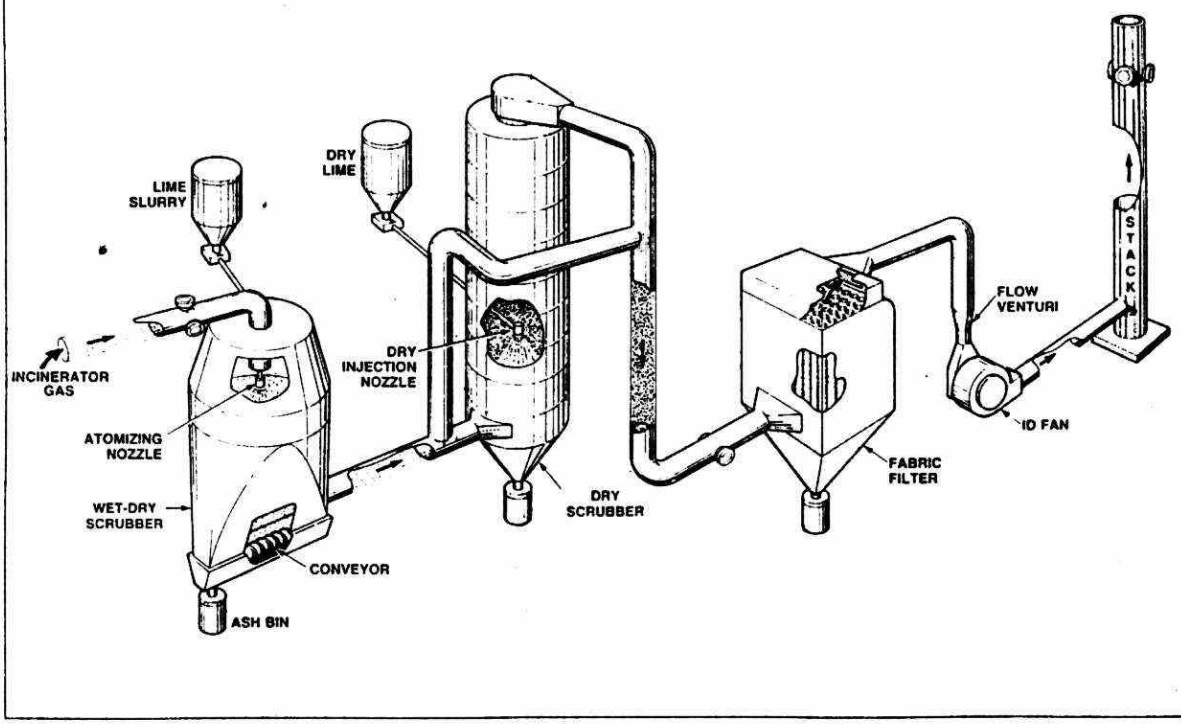
The incinerator receives municipal, commercial and suitable industrial solid waste. Each of the four units is capable of independent operation and is rated to produce 37,000 kg/hr of steam when burning 227 tonnes per day of refuse with a heating value of 13950 KJ/kg. All the steam generated is sold to Reed Paper Ltée at a guaranteed steady ($\pm$ 7%) flow and specified pressure range.

Pilot Plant Description

The principal components of the pilot plant, as shown in Figure 2, are as follows:

FIGURE 2

THE NATIONAL INCINERATOR TESTING AND EVALUATION PROGRAM (NITEP)
AIR POLLUTION CONTROL TECHNOLOGY



- a flue gas stream take-off duct (with 8 nozzles) from the electrostatic precipitator inlet of incinerator unit no. 3. The arrangement was employed to obtain a representative sample of flue gas to the pilot plant.
- a wet-dry scrubber - Flakt's DRYPAC design (also used as a gas cooler) with slurry spray nozzle and bottom screw conveyor.
- a dry scrubber - Flakt's DAS design, with a single dry lime injection nozzle and internal cyclone integral with the scrubber at the entrance.

° a pulse-jet fabric filter - Flatk's OPTIPULSE design, using high temperature Teflon bags as the filtering media with an air-to-cloth ratio of 4.4. Instrumentation included a pulse pressure controller, as well as duration and timer controls.

° an induced draft fan with flow venturi.

° a stack.

Ancillary equipment included by-pass ducts across the dry scrubber and fabric filter, removable ash hopper drums on each of the three vessels, flue gas duct isolating dampers, I.D. fan flow control damper, two lime slurry variable speed pumps with associated mix tanks, agitators, controls and a venturi/eductor dry lime feed system with variable control and lime silo. It must be noted that there are certain proprietary apsects to the design of the scrubbers and fabric filter, which would distinguish this equipment and its performance from similar equipment of other manufacturers.

The pilot plant was operated in one of two modes, as follows:

1) Dry System. The hot flue gas from the incinerator entered at about 255° to 270°C into the wet-dry scrubber (now in the role of a gas cooler) where it was cooled to the desired temperature with a water spray. It then entered the bottom of the dry scrubber tangentially into an internal cyclone. Dry hydrated lime was then air injected through a single nozzle countercurrent into the gas stream. The flue gas with entrained particulates and lime was then directed into the fabric filter dust collector.

2) Wet-Dry System. Hot flue gas from the incinerator entered the top of the wet-dry reactor at 255° to 270°C, where it was intimately mixed and cooled with a finely atomized lime slurry spray. The flue gas was then directed into the fabric filter dust collector.

For both systems, final removal of particulates, including lime, was accomplished with a fabric filter dust collector. Seventy-two bags arranged in 6 rows of 12 bags each were contained in a one compartment design. The bag material was Teflon with Gortex scrim, which is chemically inert to acid gases and has a maximum operating temperature of 250°C. The bags were supported on cylindrical wire cages with particulate collection occurring on the outside of the bag.

The pilot plant process control system was relatively uncomplicated. Temperature control was accomplished by either adjusting the rate of slurry into the wet-dry system or by water spray into the dry system. Flue gas flow was controlled by adjusting the damper at the inlet of the induced draft fan. To ensure constant flow was maintained during the tests, the pressure drop across a venturi upstream of the ID fan was continuously monitored.

Sampling Locations

Three sampling locations were selected to monitor the incinerator gases and to measure pollutants, in order to evaluate the performance of the two systems:

1. the inlet to the pilot plant to characterize the untreated raw gas from the incinerator

2. the mid-point prior to the fabric filter to characterize the scrubber performance

3. the outlet (i.e. stack) following the fabric filter to evaluate fabric filter performance and overall system performance.

In addition, all material settling out in the bottom hoppers of the scrubbers and the fabric filter were collected for analysis.

Quality Assurance / Quality Control

To ensure that the data was collected in a manner which would minimize any negative effects on data quality, an extensive third-party quality assurance/quality control program (QA/QC) was set up. This program component represented about 10% of the overall effort and was in addition to the internal QA/QC that is a routine part of all sampling programs.

Test Program Description

As in previous NITEP tests, the project was divided into two parts. The first was a characterization phase to familiarize project staff with the facility and to assess, using conventional parameters, the effect of the the various operating variables on system performance. Table I summarizes the characterization test conditions. The characterization phase test results identified that flue gas temperature and the ratio of lime to acid gas were the key parameters influencing removal efficiency of the pollutants measured.

Based on the first phase results, six performance test conditions were selected for a more detailed assessment of all parameters of interest (organics, metals, acid gases and conventional gas parameters). Table II summarizes these conditions with a rationale for selection. Each condition was tested twice to assess repeatability of results.

TABLE I SUMMARY OF CHARACTERIZATION TEST CONDITIONS

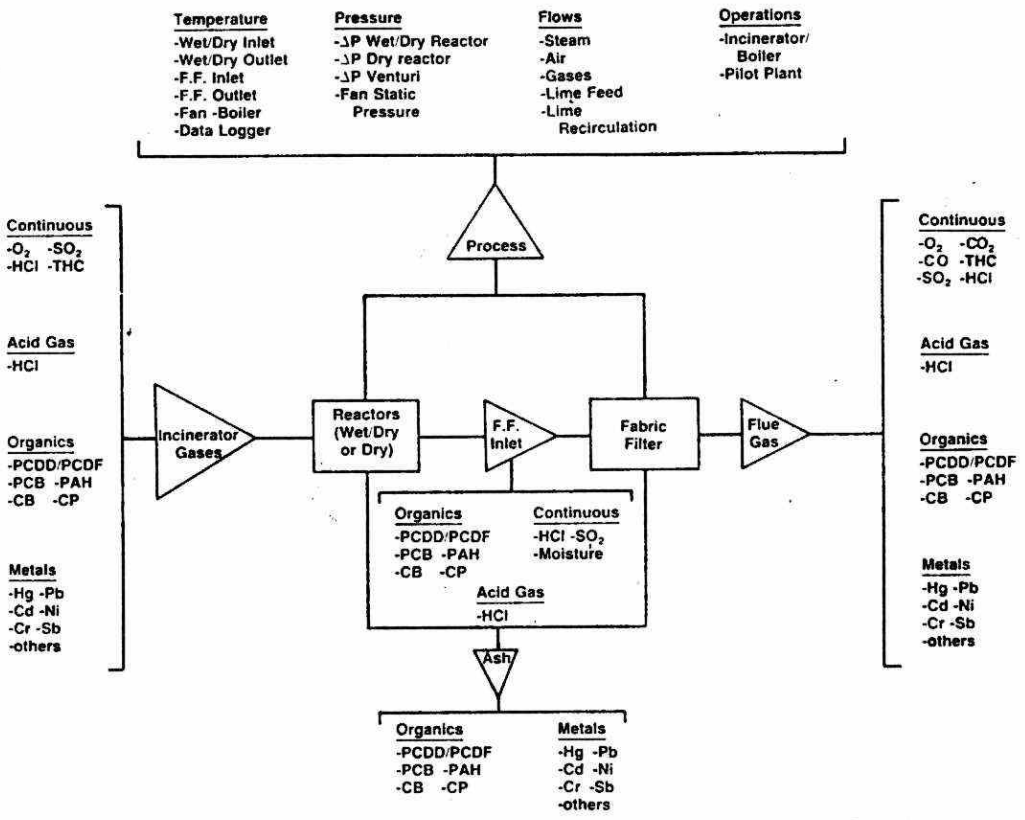
Operating Mode	Temperature After Cooling		Lime Feed Rate	Test No.
	Target °C	Actual °C		
Dry System				
Normal Temp. Operation	140	145	Normal	11
	140	151	High	4
	140	152	High (+ Recycle)	5
	140	151	Very high	3
High Temp. Operation	>200	222	Very high	2
Low Temp. Operation	125	133	Normal (+ Recycle)	12
Wet-Dry System				
Normal Temp. Operation	150	156	Normal	6, 10
	150	158	High	8
	150	158	High (+ Recycle)	9
	150	156	Very high	7
Low Temp. Operation	135	141	Normal	13
	135	144	Normal (+ Recycle)	14

TABLE II SELECTION OF PERFORMANCE TEST CONDITIONS

Operating Mode	Target Temp. Before Fabric Filter °C	Rationale
Dry System	> 200	To collect data with no gas cooling for contrast to the 3 other temperatures.
	140	Benchmark for comparison with other tests. Considered normal for full-scale.
	125	To observe potential improvements in organic removal at lower than normal temperatures.
	110	To push the limits of low temperature operation, particularly for impact on organics removal.
Wet-Dry System	140	Benchmark for comparison with other tests.
(+ Recycle)	140	To investigate whether lime recycle enhances the removal efficiency of organics and acid gases.

For each of the performance test conditions selected, sampling and data collection were conducted for the parameters shown in Figure 3. Ten manual sampling trains and 13 continuous gas monitors were operated simultaneously during these tests, requiring over 30 engineers and technicians.

FIGURE 3
PARAMETERS MEASURED DURING PERFORMANCE TESTS



Summary of Results

The most significant operating parameters measured during the performance tests are summarized in Table III.

TABLE III **KEY OPERATING CONDITIONS**

INCINERATOR	
STEAM	32,000 kg/hr
GAS AT BOILER OUTLET	280-300°C
GAS AT PILOT PLANT	250-270°C
PILOT PLANT	
LIME $Ca(OH)_2$	3.4-3.8 kg/hr
ΔP FABRIC FILTER	14-16 cm H_2O
OUTLET GAS FLOW	3,600 Nm^3/hr @ >200°C 4,100 4,300 Nm^3/hr (OTHER CONDITIONS)
CO	120-200 ppm (DRY)
OXYGEN	12-13% (DRY)
INLET PARTICULATE	6,000-8,000 mg/Nm^3 @ 8% O_2

The incinerator was operated as it normally operates at a steam production rate of 31,000 - 34,000 kg/hr. The average flow rate of the flue gas slip stream for the pilot plant was measured as 3,500 Nm^3/hr (dry). The key operating parameters for the pilot plant such as fabric filter pressure drop, lime flow rate, and flue gas temperature after cooling were carefully controlled at the selected conditions for each test.

Dioxin / Furan Results

For the parameter of greatest concern, dioxins, Table IV summarizes the inlet, mid-point and outlet concentrations and overall removal efficiencies. As is clearly evident, the greatest proportion of dioxin removal occurs across the fabric filter for both systems and under all temperature conditions tested.

Although the outlet concentration of dioxins was low for all operating conditions, there appeared to be some temperature effect at operating conditions below 140°C. Slightly higher removal efficiencies were observed at the lower temperatures.

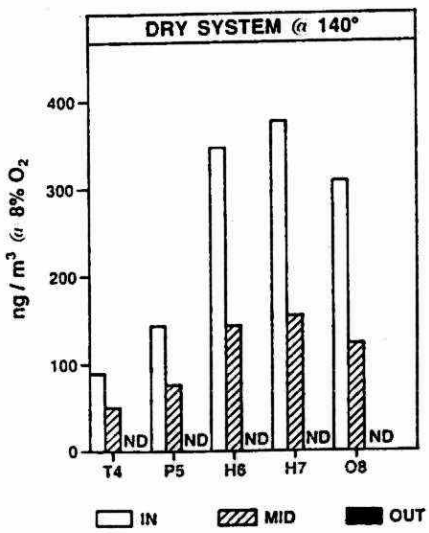
TABLE IV PCDD CONCENTRATION (ng/Nm^3 @ 8% O_2) IN FLUE GAS AND EFFICIENCY OF REMOVAL

Operating Condition	Dry System				Wet-Dry System	
	110°C	125°C	140°C	>200°C	140°C	140°C +Recycle
Inlet (ng/Nm^3)	580	1400	1300	1030	1100	1300
Mid Point (ng/Nm^3)	310	570	540	1140	840	1270
Outlet (ng/Nm^3)	0.2	ND	ND	6.1	ND	0.4
Efficiency (%)						
- Inlet/Midpoint	47	60	57	(11)	24	2
- Overall	> 99.9	> 99.9	> 99.9	99.4	> 99.9	>99.9

( ) denotes negatives.

The dioxin homologue distribution is similarly important and a typical example is shown in Figure 4 for the dry system operating at 140°C. The bell shape of the distribution curve is similar for all test conditions. The tetra's are the least prevalent with the 2, 3, 7, 8 isomer being generally less than 0.5% of the total dioxins.

FIGURE 4
TYPICAL PCDD HOMOLOGUE IN GAS

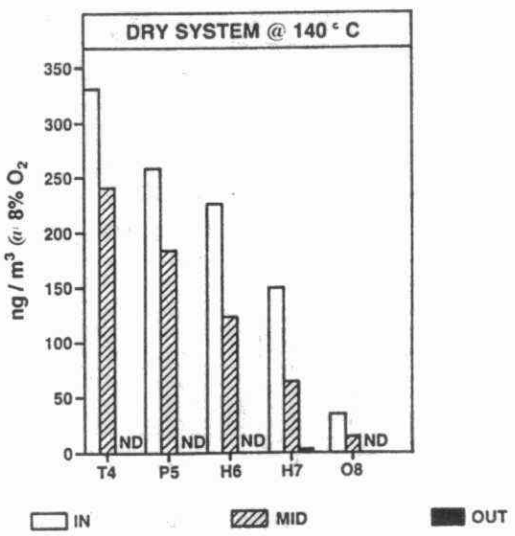


Furan removal efficiencies were similarly high (over 99.3%) as for dioxins. Table V provides the average data for each performance test condition. Figure 5 shows a typical furan homologue distribution. It is interesting to note that, in the furan homologue distribution, there is a greater prevalence of the tetra isomers.

TABLE V PCDF CONCENTRATIONS (ng/Nm^3 at 8% O_2) IN FLUE GAS AND EFFICIENCY OF REMOVAL

Operating Condition	Dry System				Wet-Dry System	
	110°C	125°C	140°C	> 200°C	140°C	140°C +Recycle
Inlet (ng/Nm^3)	300	940	1000	560	660	860
Mid Point (ng/Nm^3)	270	440	630	490	690	1030
Outlet (ng/Nm^3)	2.3	ND	1.0	1.2	N.D	0.9
Efficiency (%)						
Inlet/Midpoint	11	54	37	13	-4	-21
Overall	99.3	> 99.9	99.9	99.8	> 99.9	99.9

FIGURE 5
TYPICAL PCDF HOMOLOGUE IN GAS



Tables VI and VII provide the concentrations of dioxin and furans in the hopper ashes collected from the three vessels. The concentrations are by far the greatest in the fabric filter ash. This was expected since the fabric filter had the greatest impact on dioxin and furan removal. It is significant to note that the fabric filter ash was much finer in appearance than the scrubbers ashes. The homologue distribution of dioxins and furans in the ash phase is essentiallly identical to that noted for the gas phase.

TABLE VI PCDD (ng/g) CONCENTRATION IN ASH

Operating Condition	Dry System				Wet-Dry System	
	110°C	125°C	140°C	>200°C	140°C	140°C +Recycle
Wet-Dry Scrubber Ash	13	14	6	6	6	12
Dry Scrubber Ash	160	64	85	31	N/A	N/A
Fabric Filter Ash	280	570	470	740	160	230

N/A = Not Applicable

TABLE VII PCDF (ng/g) CONCENTRATIONS IN ASH

Operating Condition	Dry Mode				Wet-Dry Mode	
	110°C	125°C	140°C	>200°C	140°C	140°C +Recycle
Wet-Dry Scrubber Ash	10	12	4	5	5	8
Dry Scrubber Ash	87	36	64	22	N/A	N/A
Fabric Filter Ash	160	320	400	320	130	170

N/A Not Applicable

Other Organics Results

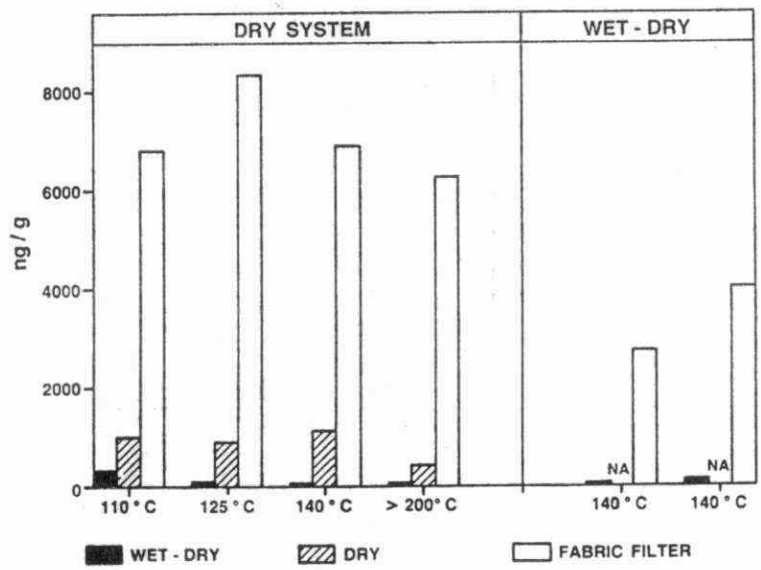
The removal effectiveness of other organics in the flue gas by the pilot plant is outlined in Table VIII. There are several significant differences between the removal effectiveness for chlorbenzenes (CB), chlorophenols (CP), polychlorinated biphenyls (PCB) and polycyclic aromatic hydrocarbons

(PAH). Essentially, the CB's, CP's and PCB's show a lower removal at higher temperatures, whereas the PAH's show the reverse relationship. At this point there is no firm rationale for this phenomena. As for dioxins and furans, the highest concentration for all the organic compounds occurs in the fabric filter ash. Figure 6 illustrates the concentrations of chlorobenzenes in the different ashes. For the other organic compounds, the distribution is similar, with highest concentrations occurring in the fabric filter ash.

TABLE VIII % REMOVAL OF OTHER ORGANICS

	Dry System				Wet-Dry System	
	110°C	125°C	140°C	200°C	140°C	140°C +Recycle
CB	95	98	98	62	>99	99
PCB	72	> 99	>99	54	>99	> 99
PAH	84	82	84	98	>99	79
CP	97	99	99	56	99	96

FIGURE 6
CP CONCENTRATION IN ASHES



Metals Results

Metal emissions are presented in Table IX indicating the overall removal effectiveness of the control system for eight of the 27 metals tested. As shown in more detail in Table X, the only notable exception occurs with

mercury at the higher (> 200°C) temperature tested, at which there is no removal of mercury. Mercury removal is significantly enhanced by operating the system at a flue gas temperature below 140°C.

TABLE IX

INLET/OUTLET METAL CONCENTRATIONS ($\mu g/Nm^3$ @ 8% O_2)

METAL	INLET	OUTLET
ZINC	80,000 - 110,000	2 - 7
CADMIUM	1,000 - 1,500	ND - 0.4
LEAD	30,000 - 45.000	ND - 5
CHROMIUM	1,400 - 3,000	ND - 1
NICKEL	700 - 2,500	0.4 - 1.3
ARSENIC	80 - 150	0.02 - 0.04
ANTIMONY	800 - 2,200	0.2 - 0.6
MERCURY	200 - 500	10 - 600

TABLE X

INLET/OUTLET MERCURY CONCENTRATIONS ($\mu g/Nm^3$ @ 8% O_2)

OPERATION DRY SYSTEM	INLET	OUTLET
110°C	440	40
125°C	480	13
140°C	320	20
>200°C	450	610
WET-DRY SYSTEM		
140°C	190	10
140°C + RECYCLE	360	19

In order to ensure that trace quantities of metals and organics in the lime did not contribute significantly to the observed levels in the ashes, an analysis was carried out and is reported in Table XI. In general, it may be concluded that metals present in the lime did not contribute significantly to the metal concentration in the ash. Organic analysis showed the lime to be a non-contributor to the presence of organic substances in the ash.

TABLE XI METAL CONCENTRATIONS IN LIME VERSUS METALS IN HOPPER ASH (ug/g)

Metal	Lime	Dry System	Wet-Dry System	
		Fabric Filter	Wet-Dry Scrubber	Fabric Filter
Zinc	40	18 000	4 000	13 000
Cadmium	10	320	35	180
Lead	250	7 800	1 500	6 000
Chromium	40	170	190	200
Nickel	30	47	100	95
Antimony	ND	280	40	200
Arsenic	4	42	5	20
Mercury	ND	220	4	90

Acid Gas Results

The ability of the two systems to reduce the emission of acid gases was evaluated for several different operating modes. Tables XII demonstrates the impact of operating conditions on acid gas removal. It is clearly evident that temperature is a major factor for acid gas removal, which is consistent with observations for organics and metals. At the lower operating temperatures, the removal efficiencies are significantly higher than at the higher temperatures. There appears to be no significant difference between the dry and wet-dry systems for acid gases removal; however, the recycle condition (wet-dry mode) did show that less lime was required to achieve the same removal efficiency as without recycle. This is a significant finding as it has the potential to reduce operating costs by reducing lime consumption.

TABLE XII HCl & SO_2 CONCENTRATIONS (@ 8% O_2) & COLLECTION EFFICIENCY

Operating Condition	Dry System				Wet-Dry System	
Flue Gas Temp. at F.F. Inlet	110°C	125°C	140°C	>200°C	140°C	140°C +Recycle
Stoichiometric Ratio	1.21	1.10	1.10	1.60	1.36	1.16
Hydrogen Chloride						
Inlet (ppm)	410	430	450	360	360	450
Midpoint (ppm)	15	66	120	190	140	140
Outlet (ppm)	7	9	28	84	28	40
Eff to Midpoint (%)	96	85	73	47	56	68
Eff Overall (%)	98	98	94	77	91	91
Sulphur Dioxide						
Inlet (ppm)	110	110	80	110	100	100
Midpoint (ppm)	23	63	61	99	63	66
Outlet (ppm)	4	10	39	79	33	40
Eff to Midpoint (%)	80	45	35	11	36	35
Eff Overall (%)	96	92	58	30	66	61

Conclusions

The following key conclusions have been drawn from the extensive test data on the Flakt pilot plant system:

1. Both the wet-dry system using lime slurry and the dry system using powdered lime, followed by a fabric filter, are capable of high removal efficiency for all pollutants of concern, with no significant difference in removal efficiency by either system.

2. Cooling of the flue gas temperature was a key operating parameter for effective removal of HCl, SO_2 and mercury for both systems.

3. The removal efficiencies for dioxins and furans were very high, exceeding 99%. For most test runs, the concentrations of dioxins and furans after the control system approached the detection limits of the sampling and analytical methods employed.

4. The highest dioxin and furan concentrations in the ashes occurred in the fabric filter ash and the lowest concentrations were found in the scrubber ashes. These results were anticipated based on the high removal efficiency of dioxins and furans across the fabric filter collector.

5. Other trace organics, such as chlorobenzenes (CB), polychlorinated biphenyls (PCB), chlorophenols (CP) and polycyclic aromatic hydrocarbons (PAH) were also efficiently removed (80 - 99%) by both systems when operated under cooled flue gas conditions.

6. Concentrations of trace organics in the various hopper ashes followed a simlar pattern as for dioxins and furans, whereby the highest concentrations occurred in the fabric filter ash.

7. Metal collection efficiencies generally exceeded 99.9% with both systems except for mercury, for which flue gas cooling was essential to maintain a high removal efficiency.

8. Low emissions of acid gas can be accomplished by either increasing the ratio of lime to acid gas or by cooling the flue gases. However, flue gas cooling is a more economical approach since increasing lime utilization is more costly.

9. Ash recycle (i.e. fabric filter ash containing some residual unreacted lime) added to the fresh make-up lime was beneficial in providing the same SO_2 removal efficiency as the no-recycle condition. By recycling ash, less fresh lime was used, which reduces operating cost.

10. Two key independent variables tested were flue gas temperature control and the ratio of lime to acid gas concentration. Temperature was found to be the most significant variable in affecting removal efficiency.

Ontario Hydro Acid Gas Control Program - Limestone Injection Program at Lakeview

by C.J. Barnett[1] and D.K. Fung[2]

About one-third of Ontario Hydro's electrical power is obtained from burning coal. The total capacity for coal-fired stations is about 9000 MW. While scientists have estimated that not more than 5 percent of acid gas depositions in Ontario are attributable to Ontario Hydro operations, Ontario Hydro is the second largest acid gas emitter in the province, emitting about 400,000 tonnes (1985) of sulphur dioxide and nitrogen oxide gases per year to the environment.

For this reason, the Ontario government invoked the Environmental Protection Act and regulated Ontario Hydro three times (Ontario Regulation 73/81, 7/82, 662/85) over the last five years to limit its emissions (Table 1).

To be able to comply with these regulations, Ontario Hydro is carrying out a variety of studies to reduce acid gas emissions.

The various alternatives available to us are: (Table 2)

(a) Maximum use of hydroelectric and nuclear power. This will reduce the use of coal. However, the majority of the economical hydroelectric power sites are already utilized, water flow is seasonal and, therefore, significant additions to meet future load growth are unlikely. Nuclear generating stations are run as base-load stations due to their low fuelling cost and cannot readily be adapted to meet varying energy demands over a daily cycle;

(b) Increased use of low sulphur fuel. Natural gas and oil can be used but historically are expensive. Another approach is to use a lower sulphur coal which has a somewhat lower energy content. The two latest fossil-fuelled generating stations have indeed been designed to burn this kind of coal (lignite);

(c) Coal Cleaning. High sulphur coal can be "washed" to remove much of the sulphur. Indeed, most of the coal Ontario Hydro uses has been washed for this purpose as well as to reduce coal and ash handling. Of course, a premium is paid for washed coal;

(d) Conservation. More efficient electrical equipment or appliances will reduce energy consumption and, therefore, less electricity demand will reduce coal requirements. Wise use of electricity will have a similar effect;

(e) Alternative forms of electricity. Other forms of electricity generators such as wind, solar or biomass can also help supplement generation and therefore reduce coal consumption;

(f) Acid rain precursor removal. It is well accepted that the two main acid rain precursors are nitrogen oxides (NO_x) and sulphur oxides (SO_x). NO_x emissions are normally the smaller portion of total acid gas emissions from a utility

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boiler but their contribution to acid rain has been recognized more and more in recent years. Low NO_x burners have been developed to control flame temperatures and reduce the amount of NO_x formation. Existing burners can be modified to these characteristics. A number of ways has been developed to remove SO_2.

NO_x Reduction Program

The modification program at Ontario Hydro's Nanticoke generating station was started mainly to control the appearance of the "brown plume" which occurred under certain atmospheric conditions and usually at a NO_x concentration of more than 500 ppm. The reduction of NO_x for acid rain control emphasized the need for these design modifications.

Since the late 1970's there have been many engineering studies done to reduce NO_x emissions from Nanticoke GS such as impeller change, staged combustion simulation, variation of excess air and reduction of mill outlet temperature. The first two changes incurred the greatest NO_x emission reductions and are the major engineering changes that have been incorporated into the Nanticoke low NO_x burner modification program. The program is being carried out in co-operation with the boiler manufacturer. Three of the eight boilers have been converted and have achieved a NO_x reduction of greater than 25 percent. The remaining five units will be converted by 1988.

SO_x Reduction Developments

There are many ways to remove SO_2. Some are well established commercial systems, some are going through extensive testing and new technologies are being developed. There are three approaches which use limestone/lime as a sorbent medium (Table 3).

(a) Flue Gas Scrubbing - There are various processes for scrubbing the flue gas, commonly known as the FGD systems. These can be wet or dry processes, and usually treat the flue gases immediately prior to the chimney discharge. They usually involve high capital and operating costs with generally high removal efficiency (90%).

(b) Fluidized Bed Combustion - This process has been developed on smaller units and a commercial application on boilers of 160 MW is currently being constructed. The low level of SO_2 emission is achieved by feeding limestone with the coal to the boiler bed. Combustion temperatures are relatively low; consequently NO_x emissions are about one third of that from a conventional utility boiler. Ontario Hydro is actively following progress with this technology for potential future boiler applications.

(c) Limestone Injection to the Furnace (LIF) Demonstration

This system has been developed by Ontario Hydro in conjunction with Combustion Engineering, the boiler designer and manufacturer. The installation was made in the Fall of 1985 on one unit at the Lakeview Generating Station which is located just west of Toronto. This was the first large (300 MW) unit in North America to be fitted with this system and has resulted in considerable interest from outside utilities and organizations.

Two sets of tests have been carried out in 1985, the exploratory tests in January and the development tests in December. The optimization tests will be carried out in June-August of this year.

Initial testing in late 1985 showed the process to have considerable development potential for economic SO_2 reduction. Removal of SO_2 was about 40 percent and the process was relatively simple to install and operate when compared to conventional scrubbers. Unlike the scrubber type mentioned in (a) above, the LIF process removes SO_2 in the hot flue gas leaving the furnace.

Basically the process involves the injection of limestone (calcium carbonate) in a finely powdered form into a furnace zone with a temperature of 980-1200°C (1800-2200°F) (Figure 1). The heat calcines the limestone to calcium oxide which presents a large surface area for absorption of SO_2 in the gas stream. If the gas temperature at the injection zone is too high (2200° F+) the limestone sinters or "dead burns" with a consequent loss of effectiveness.

The calcium oxide absorbs SO_2 and forms calcium sulphate (gypsum) which is carried as particulates in the gas stream and is collected in the electrostatic precipitators (dust collectors) before the gas enters the chimney. The excess loading of particulates affects the operating efficiency of the precipitator and design improvements will be necessary for commercial application. Preliminary results are as shown in Table 4. In all cases the opacity measurements were found to be below MOE limits.

At about 70 percent load on the unit (220 MW), with a limestone injection rate of 12.5 tons/hour (Ca/S ratio of 3:1) the average SO_2 reduction from baseline was about 40-43 percent. Reduction of SO_2 capture decreased with lower limestone injection rates. At 10.2 tons/hour for example, the SO_2 capture was reduced to the 30-40 percent range. Higher temperature and shorter limestone residence time appeared to affect (reduce) SO_2 reduction[1].

The 3:1 injection ratio led us to speculate that there would be residual lime left unreacted in the ash. Indeed, the ash we collected was found to contain about 33 percent CaO, similar to the LIF ash we obtained from a test facility in the US and close to the maximum level expected theoretically.

A series of tests was carried out to characterize this new ash. Its chemical composition, exothermicity, particle size and MOE leaching characteristics were all determined on ash produced in the January 1985 exploratory tests and the December development tests as well as on the ash from US. The same parameters will be tested again for ash produced in the current optimization tests.

Chemical parameters of major interest are shown in Table 5.

Exothermicity is of major concern to us as far as handling and disposal of the material is concerned. Laboratory tests as well as monitoring the temperature change during loading, transfer, and unloading were carried out. Average results are also shown in Table 5. The interesting point through observation of the temperature data is the difference between high Tmax for the December and Consol (US) ashes and the low Tmax for the January test, even though they all contain roughly 33 percent CaO. Energy due to bonding reactions between lime and fly ash and heat of hydration of $CaSO_4$ were looked at but were discarded as the main causes for the difference in behaviour. It was concluded that the lime from the January ash contained a lot more dead-burnt lime, a product from calcination of limestone in a super-hot reaction chamber. This was confirmed through calorimetric studies of the ashes. Over time, all three ashes gave out the same quantity of heat[2]. It is also interesting to note that the heat of reaction of the ashes (ΔH = -68.9 Cal/g for the Consol ash, -77 Cal/g for the December ash) is about 1/3 of the heat of slaking of quicklime (ΔH = -230 cal/g). This is quite in agreement with the ~ 33 percent CaO content in the ash.

Leaching tests were carried out using the then-standard MOE Regulation 309 Blueprint methodology for both mono-fill and co-disposal procedures. Results are as shown in Table 6 (3, 4). Except for a few exceptions (TDS, Cr, pH), the material is fit for either mono-fill or co-disposal.

The ash was disposed of at two sites - the Britannia Landfill site by covered tracks and the Nanticoke Ash Disposal Site by totally enclosed tankers which discharged the ash through the existing ash management system. The Municipality of Peel and the Central and South-West Regions of the Ministry of the Environment monitored closely the development of these disposal

processes. There have been no real safety or environmental problems associated with the disposal methods so far (Figure 2, 3, 4).

Ontario Hydro is expending considerable effort in the next phase of test work at Lakeview to address three basic areas:

(1) The optimum injection location in the gas stream.

(2) The most economic and effective methods of enhancing the precipitator performance when collecting this combination of fly ash, reaction products and unreacted reagent.

(3) The commercial use for this particular waste material collected in the precipitator as possibly a low grade cement ingredient or other useful application.

The Phase 2 development program will be carried out over the summer of 1986 and is expected to assist in the determination of the capital and operating costs which would be associated with a permanent installation. These costs and the expected removal efficiency are required to confidently compare to the more established scrubbing systems to assess the best type of process to meet our future acid gas reduction needs.

Reference

1. J.A. Arnott, Lakeview Unit 4 Limestone Injection Preliminary Test Results January 17, 1986 File 908-NA21-3/4 - 34.21 P.

2. A. Golomb LIF Waste Characterization for Handling/Disposal - 1985. January 10, 1986 Report No. 85-340-K.

3. D.K. Fung etl. Task Force Report - LIF Lakeview Demonstration Program Waste Management June 1985. Report No. 85230.

TABLE 1

Acid Gas Control Regulations for Ontario Hydro

		Kilo-Tonnes of Acid Gas Allowed		
		NO_x	SO_2	Total
Regulation 7/82	before 1989	60	390	450
	after 1989	40	260	300
Regulation 662/85	1986-1989		370	430
	1989-1993		240	280
	after 1993*		175	215

* With banking allowed.

TABLE 2

Alternatives of Acid Gas Control Program

(a) Maximum use of hydroelectric and nuclear power.

(b) Use of low sulphur fuel.

(c) Coal cleaning.

(d) Conservation.

(e) Solar/wind/biomass energy etc.

(f) Purchase from neighbouring provinces.

(g) Removal of acid rain Precursors.

TABLE 3

SO_x Reduction

(a) Flue Gas Desulphurization - various forms.

(b) Fluidized Bed Combustion.

(c) Limestone Injection to the Furnace (LIF Program).

TABLE 4

Lakeview Limestone Injection
Performance Test Results
Preliminary

	Load (MW)	OFA* (lb/hr)	Limestone (t/hr)	Ca (OH)2 (t/hr)	SO2 Reduction (%)
1.	220	2000000	12.5	0	42.8
	220	0	12.5	0	40.6
2.	220	2000000	10.2	0	39.5
	220	0	10.4	0	31.5
3.	220	2000000	0	2.6	30.5
	220	2000000	0	4	35.4
	220	2000000	0	4.4	36.5
4.	285	2000000	14.6	0	25
	285	0	13.8	0	21.8

* Overfire air introduction

TABLE 5

Analytical Results
Characteristics of LIF Ash

	LIF Ash January 85	LIF Ash December 85	LIF Ash Consolidated
CaO (µg/g)	331	350	333
$CaCO_3$ (µg/g)	< 30	69	80
$CaSO_4$ (µg/g)	55	67	182
$Ca(OH)_2$ (µg/g)	< 30	< 30	< 30
Unburnt C (µg/g)	92	75	129
Bulk Slaking max T°C	-	162	160
Calorimetric max T°C	51	100	98
Actual Field max T°C	40	98	-

TABLE 6

MOE Leachate Extraction of Hopper LIF Ashes

Parameter	Co-Disposal Ash Jan 85	Co-Disposal Ash** Dec 85	Monofill Ash June 85	Monofill Ash** Dec 85	Maximum Permissible Extract Concentration
pH	12.5	12.8	12.6	12.8	-
TDS	N.A.	N.A.	4080	3760	2500
F	1.1	1.6	1.3	1.15	2.4
Cl	16.2	49.0	16.3	52	1250
SO_4	1100	1327	1280	1436	2500
NO_2(N)	0.025	0.003	0.026	<0.003	1
NO_3(N)	0.027	0.050	0.050	0.05	10
TOC	N.A.	N.A.	<2	<1	25
B	2.8	3.8	3.1	4.0	5.0
N(organic)	<0.06	0.15	<0.06	0.08	0.75
Ra-226	2.0	3.10	1.2	2.10	3 pCi/L
PCB	0.0006	0.0016	<0.0002	<0.001	0.003
Phenol	<0.001	0.006	<0.001	< 0.004	0.01
CN (WAD)	<0.04	<0.04	<0.02	0.04	0.2
Ba	<1	<1	<1	<1	1
Cr (total)	<0.02	0.13	0.2	0.12	0.05
Cu	<0.1	0.002	<0.002	0.003	5
Mn	<0.05	<0.05	<0.05	<0.05	0.25
Zn	<0.05	<0.02	<0.02	<0.02	25
Fe	<0.25	<0.02	<0.1	<0.05	1.5
Ag	<0.0004	<0.0002	<0.0003	<0.0002	0.05
Pb	<0.004	<0.002	<0.002	<0.002	0.05
Cd	<0.0004	<0.0001	<0.0003	<0.0002	0.005
As	<0.001	<0.001	<0.001	<0.001	0.005
Se	0.006	0.017	0.008	0.016	0.01
Hg	0.0009	<0.0002	<0.002	<0.0002	0.001
U	<0.05*	<0.02	<0.05*	<0.01	0.02

Notes: All concentrations given in mg/L except for Ra-226, which is given in pCi/L.

N.A. denotes not applicable, due to acetic acid additions.

* analytical interference due to high Ca concentration in sample.

** preliminary results, A. Golomb to D.K. Fung, May 13, 1986.

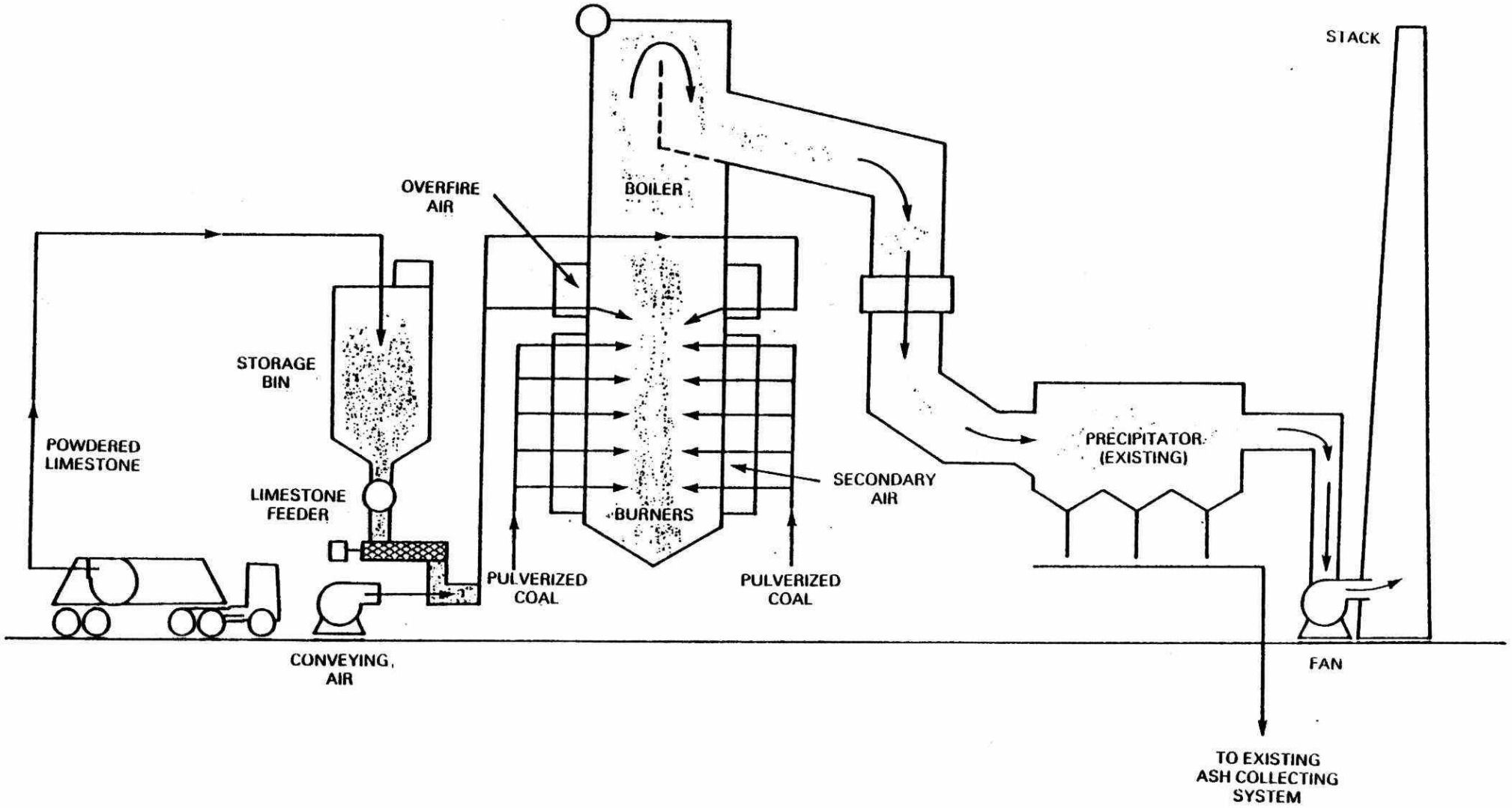

FIGURE 1

SO_2 - Limestone Injection into Furnace
(Development Project at Lakeview TGS Unit No. 4)

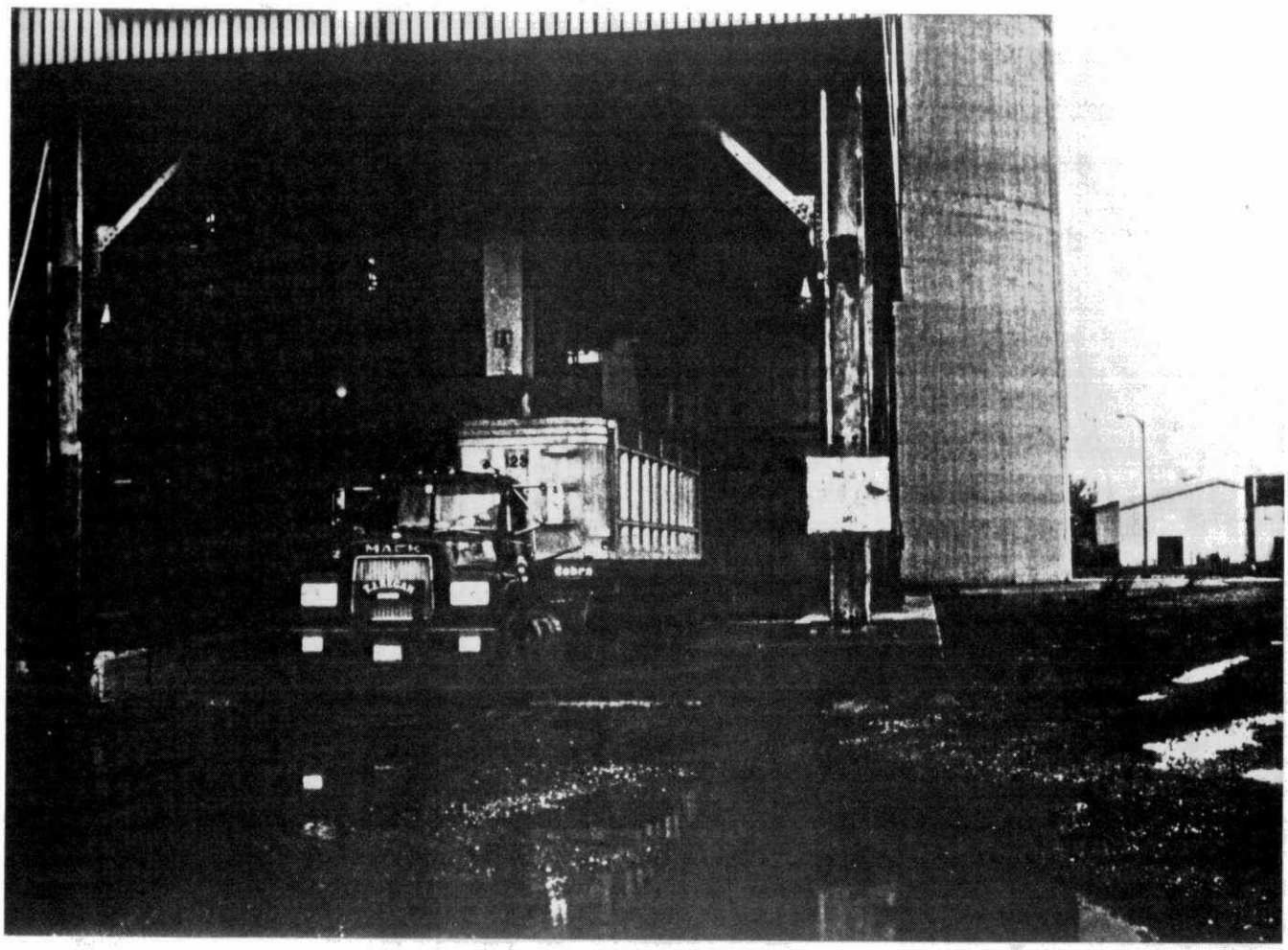

FIGURE 2

Loading of LIF Ash into
Covered-Truck from Station Silo

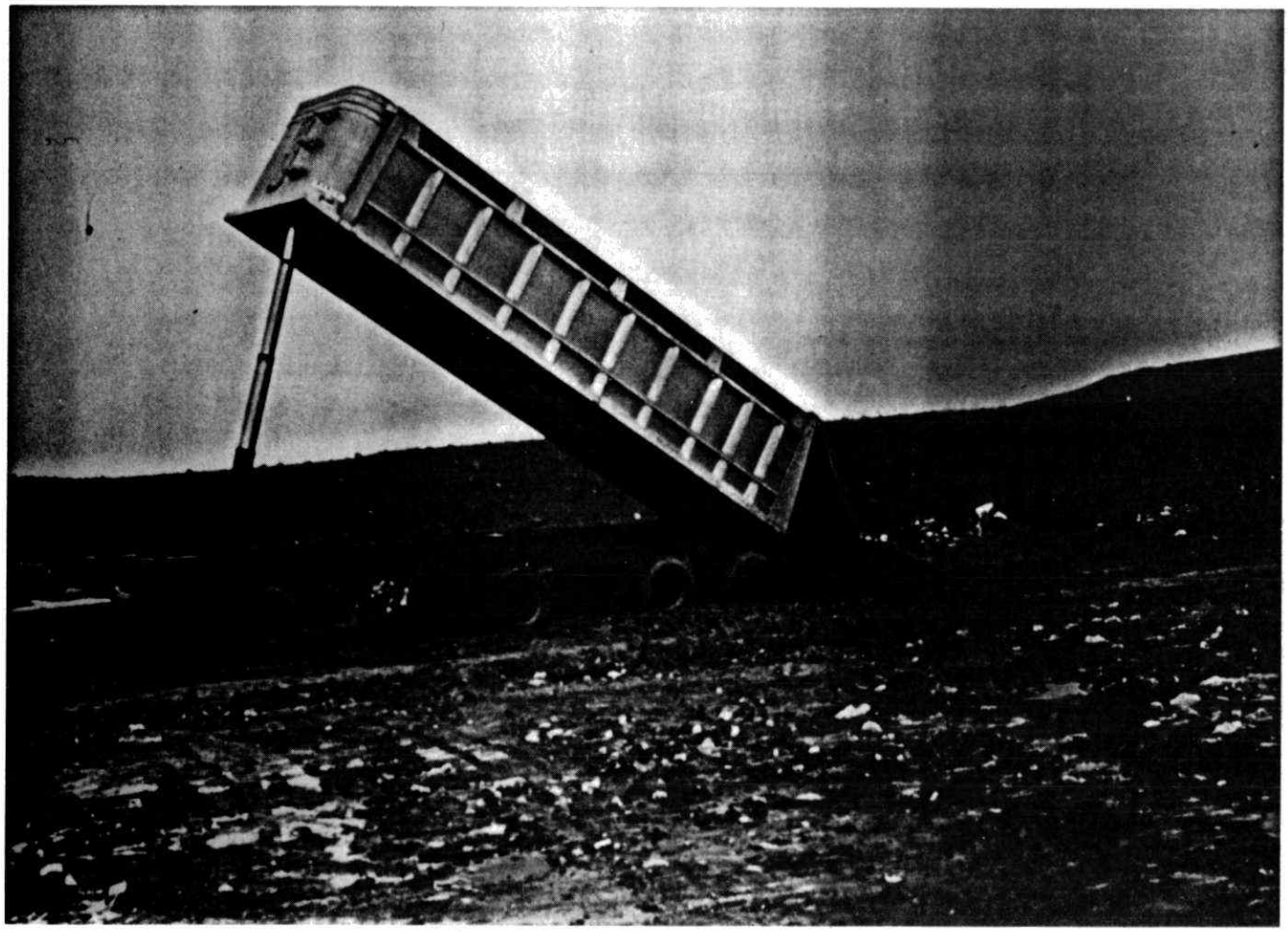

FIGURE 3

Dumping of LIF Ash
onto Landfill Site

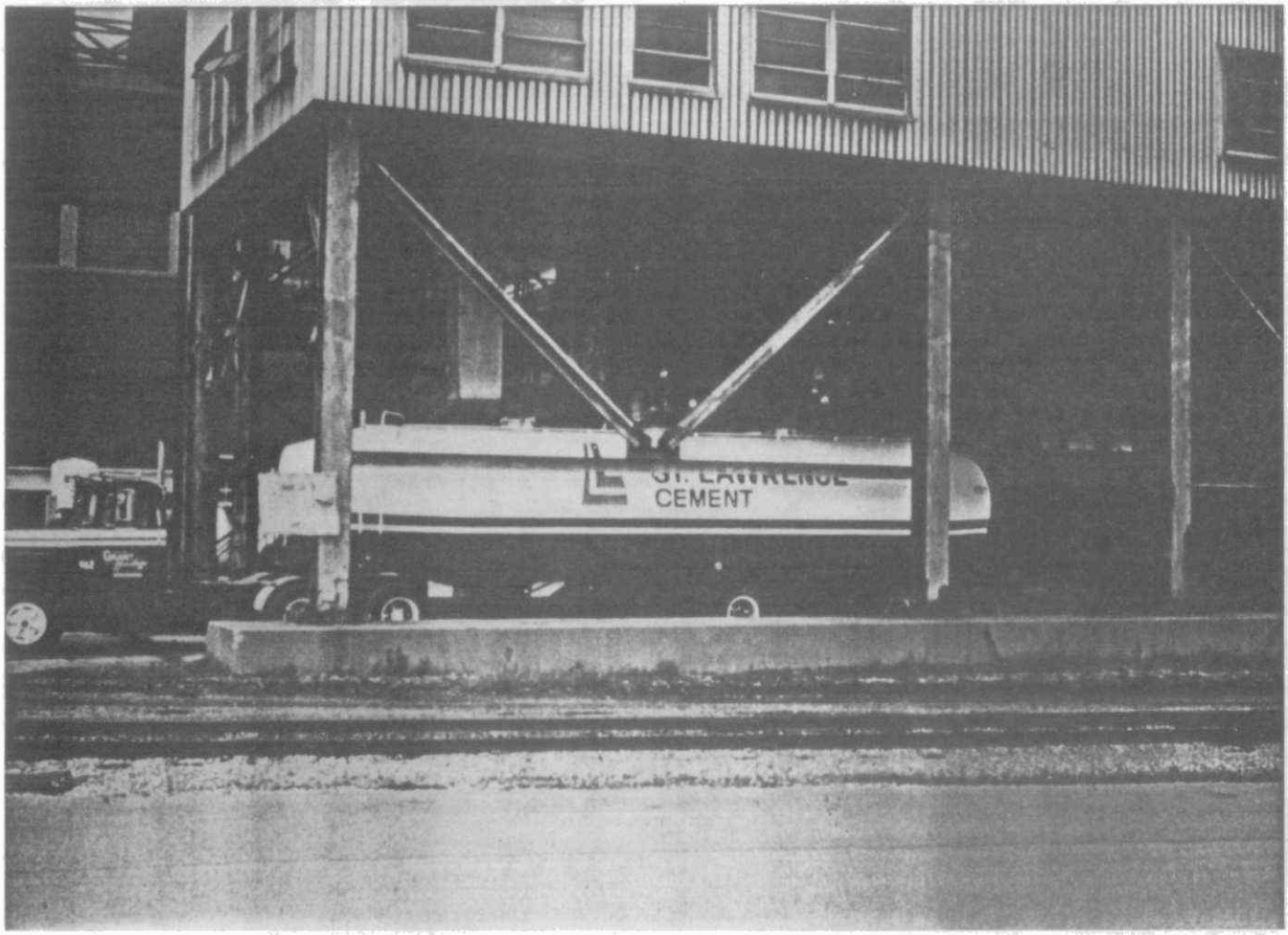

FIGURE 4

Loading of LIF Ash
Into Tanker from Station Silo

MOBILE AMBIENT AIR MONITORING

by R. W. Bell and G.B. De Brou,
Air Resources Branch, Environment
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Since 1968, the protection and assurance of air quality in Ontario has been the mandate of the Ministry of the Environment. To meet the requirements of this mandate, the MOE established a network of permanent air quality stations. By the late 1970s, more than 1,250 air quality instruments had been installed at over 125 sites.

Realizing that all environmental problems could not be addressed by this fixed network approach, the Air Resources Branch initiated a mobile air monitoring programme. Like the air quality networks, the original mobile air monitoring units (MAMUs) were devoted to the determination of ambient levels of the classical pollutants, including: carbon monoxide, sulfur dioxide, total reduced sulfur compounds, nitrogen oxides, mercury, ozone and total hydrocarbons.

As the analytical technology progressed, the capabilities and role of the MAMUs expanded. Today the Air Resources Branch operates three (3) state-of-the-art mobile air monitoring units. These units are completely self-contained mobile laboratories that can be dispatched to any area of the Province to quickly determine pertinent air quality profiles in order to assist in the assessment of environmental problems.

The first two mobile units (MAMUs 1 and 2) possess similar capabilities. In addition to monitoring the classical pollutants, these MAMUs routinely measure over 130 distinct volatile hydrocarbons using advanced gas chromatographic (GC) techniques.

The third mobile unit (MAMU 3) contains an atmospheric-pressure, chemical ionization mass spectrometer (APCI/MS), affectionately known as the TAGA system. This mass spectrometer can provide instantaneous concentrations of a wide range of volatile organic and inorganic contaminants at ultra trace levels. Thus MAMU 3 is particularly useful for screening polluted air for unknown contaminants and tracking such contaminants to their source of origin.

The on-site meteorological parameters currently monitored by these MAMUs are wind speed, wind direction, ambient temperature, barometric pressure, humidity and solar radiation.

2.0 THE MAMUs

The chosen vehicle for all 3 MAMUs was the "GMC Transmode": a 26 foot recreational van which is both stylish and practical. A smooth, low-vibration ride is characteristic of the self-adjusting air bag suspension. Being a front-wheel drive vehicle, there is ample flat floor space to accommodate the scientific instrumentation. Sketches of the MAMU floor plans are shown in Figure 1.

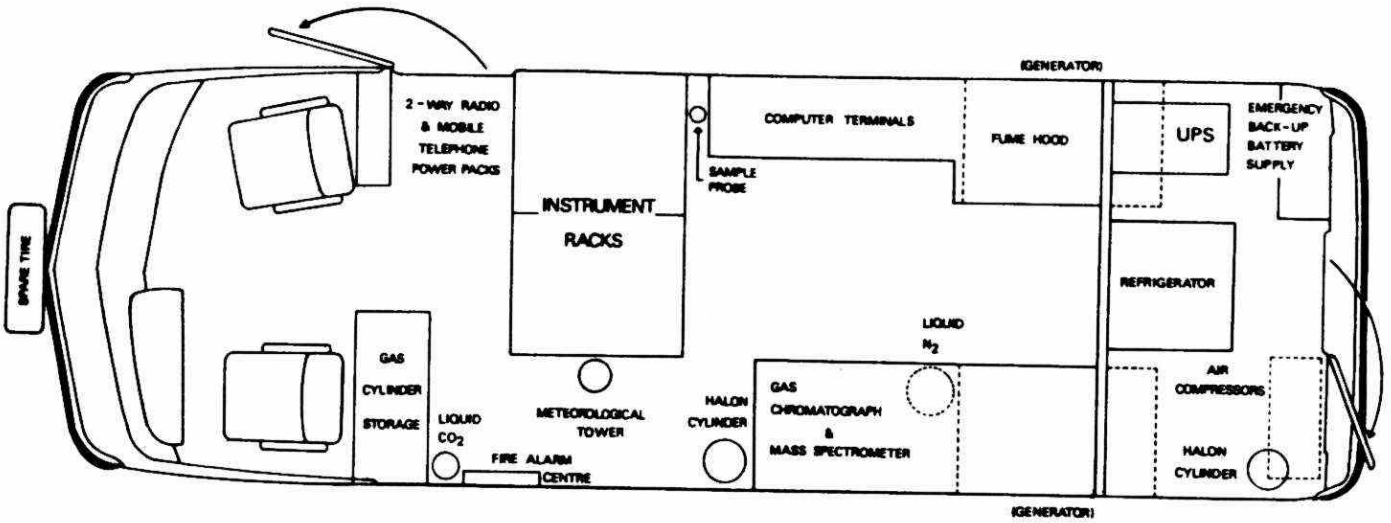
Each MAMU is powered by two 6 kilowatt generators with electronic frequency controllers. Two independent circuits permit the electrical isolation of the sensitive scientific instrumentation from the auxillary equipment (e.g. air conditioners, heaters, pumps, refrigerators, etc.). An uninterruptable power supply protects the on-board computers during a power failure. Also, since each generator can supply power to either or both circuits, analytical equipment can remain functional in an emergency monitoring situation even if one generator should fail.

An important feature of the units is the communication package. Each MAMU has a mobile radio telephone for efficient communication throughout most of southern Ontario. In addition, each unit has a 110 watt 2-way radio system with a unique Ministry frequency. Thus the Ministry is assured of a closed communication link with the MAMUs; this is especially important during emergency monitoring when transferring vital air quality information to the command centre is essential.

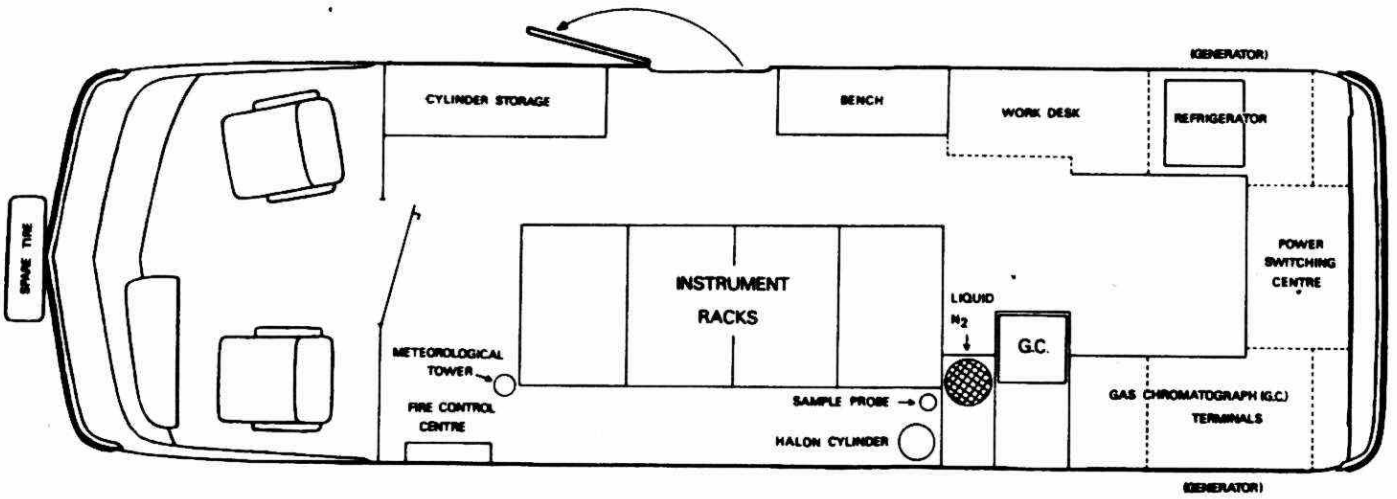
All MAMUs have a complete meteorological sensing system. A wind vane and anenometer mounted on a 10 metre telescopic tower provide local wind speed and wind direction data. Ambient temperature, barometric pressure, and solar radiation are also monitored. MAMUs 1 and 2 are equipped with minisondes and an automated dual theodolite tracking system to give upper air temperatures and wind profiles. The simultaneous acquisition of meteorological parameters and air quality data is essential for source delineation.

Since each MAMU represents a capital expenditure of roughly one million dollars, the units are equipped with fire, vandalism, and power loss sensors. When activated, a microprocessor-controlled alarm system will transmit an alert over the 2-way radio network requesting immediate action. If no action is forthcoming, the automated systems will take over. For example, in the event of a fire, a "Halon gas system" will be automatically activated.

MOBILE AIR MONITORING UNIT (MAMu) #1



MOBILE AIR MONITORING UNIT (MAMu) #2



MOBILE AIR MONITORING UNIT (MAMu) #3

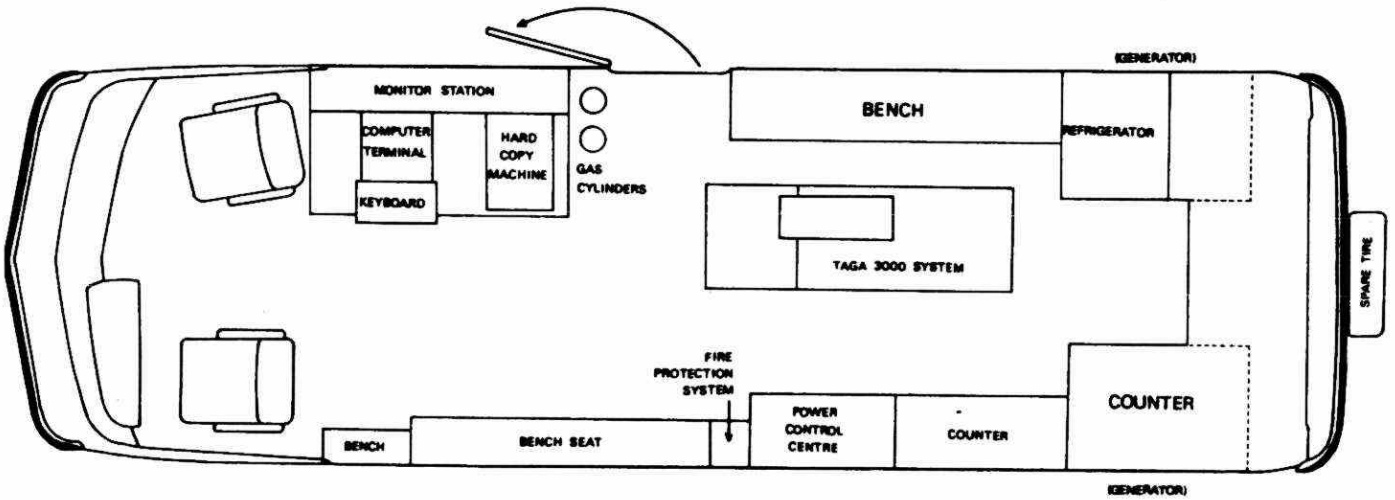


Figure 1: Floor plans: MAMUs 1, 2, and 3.

2.1 Analytical Instrumentation

2.1.1 Classical Pollutants

The MAMUs 1 and 2 are equipped with several discrete analyzers to measure the classical pollutants on a continuous basis. Instrumentation common to both MAMUs include the following:

- o A dual flame ionization analyzer to measure total hydrocarbons, non-methane hydrocarbons and methane.
- o A filter correlation spectrometer for monitoring carbon monoxide.
- o A chemiluminescent, dual channel analyzer to monitor oxides of nitrogen, nitrogen monoxide and nitrogen dioxides.
- o A fluorescent sulfur dioxide analyzer. This analyzer serves two purposes: firstly, to measure sulfur dioxide; and secondly, to measure total reduced sulfur compounds when the sample gas is diverted through sulfur dioxide scrubbers and a high temperature converter.
- o An ultraviolet absorption ozone analyzer.

In addition to the above analyzers, MAMU 2 contains an ultraviolet spectrometer for the detection of elemental mercury and a second sulfur dioxide analyzer. Utilizing two SO_2 analyzers, one with a SO_2 scrubber and a high temperature converter system, permits simultaneous measurements of SO_2 and TRS.

The functions of data acquisition, span and zero for all instruments are under computer control. Thus, once the instruments have been calibrated and set in the monitoring mode, air quality data are acquired continuously without the need for operator interaction. Every 30 seconds, current pollutant levels are printed and displayed on a CRT for operator evaluation. Back at home base, the acquired data are transferred to a larger more powerful computer for detailed data reduction and analysis.

2.1.2 Volatile Organic Compounds (VOCs)

The detection and quantitation of volatile organic compounds in the environment are becoming increasingly important. In polluted air there are perhaps hundreds, if not thousands, of VOCs. Of course, the exact number of volatile contaminants detected depends mainly on the sensitivity and selectivity of the analytical techniques employed. Thus a major thrust of our research has

been in the area of VOC monitoring using two techniques: 1) specialized gas chromatography (GC) and 2) atmospheric-pressure, chemical ionization mass spectrometry (APCI/MS).

Both the MAMUs 1 and 2 utilize identical GC technology developed by our laboratory. Because a majority of the volatile contaminants are present at trace levels, air samples must be preconcentrated prior to GC analysis. Preconcentration is accomplished in two stages: firstly, contaminants are selectively sampled and trapped by a multi-component adsorbent cartridge; and secondly, following thermal desorption, contaminants are prefocussed by cryocooling low volume loops. Contaminants are identified using a sophisticated GC with two high resolution capillary columns of different polarity, each coupled to a flame ionization detector.

The GC preconcentrator systems in MAMUs 1 and 2 are appropriate for monitoring the less reactive contaminants. Target compounds of interest must be in the retention index library to be automatically identified and quantified. Currently the system is calibrated for 132 hydrocarbons with 3 to 12 carbon atoms. The following chemical classes are represented: alkanes, alkenes, alkynes, aromatics and chlorinated hydrocarbons. Detection limits are typically in the range of 0.1 to 1 ug/m^3 for a 1 hour sampling period.

The third MAMU contains a single, yet very powerful analytical instrument - The Trace Atmospheric Gas Analyzer (TAGA) model 3000. Basically the TAGA is a specialized quadrupole mass spectrometer (MS) with an atmospheric-pressure, chemical ionization (APCI) ion source. The fundamental features of the TAGA are shown in Figure 2. Ambient air is sampled at a high flow rate (100 l/min) directly into the APCI ion source. Contaminants are selectively ionized through low energy chemical ionization initiated by a stable corona discharge. Ionized pollutants are then immediately mass analyzed by the quadrupole mass filter. The entire process - sampling and analysis - occurs in less than a second.

Direct air sampling together with APCI affords real-time response to a broad range of organic and inorganic pollutants at ultra trace levels. The contaminants detectable by the TAGA constitute a variety of chemical classes, namely: alcohols, amines, aldehydes, amides, ketones, esters, acids, phenols,

TAGA 3000 SYSTEM

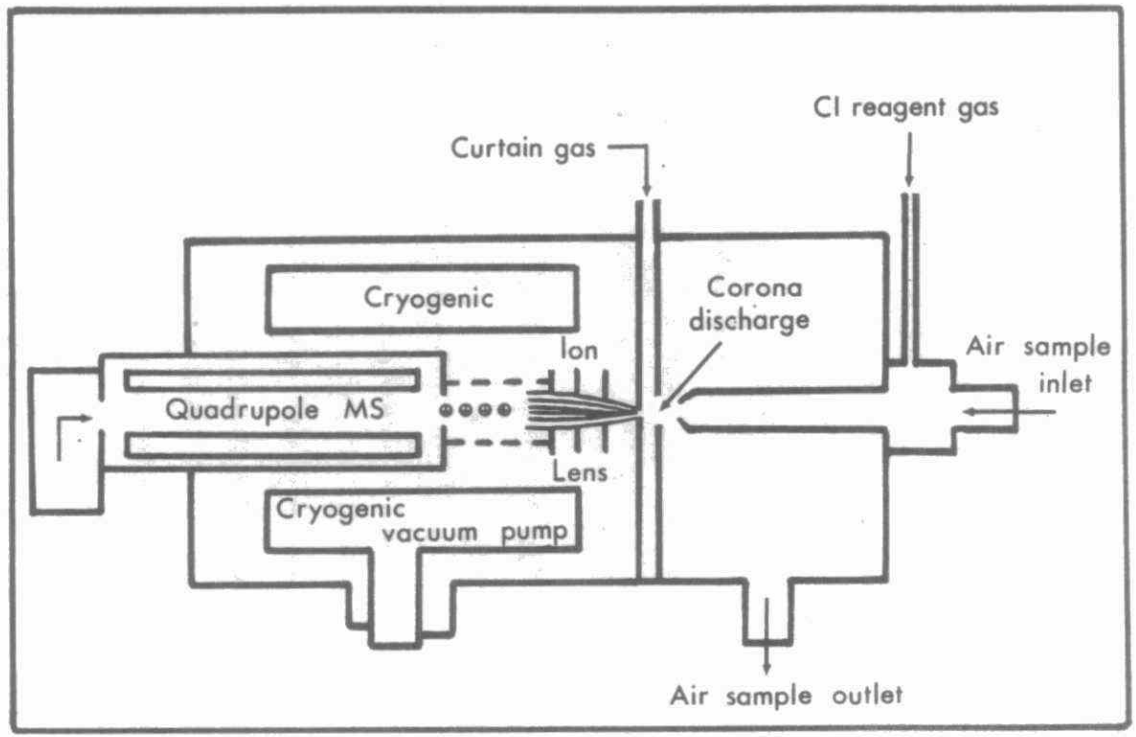


Figure 2: Schematic of the TAGA 3000 system installed in MAMU 3.

sulfides, disulfides, mercaptans and chlorinated aromatics. In general the TAGA system is sensitive to any volatile compound containing a heteroatom, such as N, O, S, or halides.

The mass spectrometer can be operated in either of two modes: (a) mass scanning (MS), where air samples are screened over a mass range of 10 to 560 atomic mass units; or (b) selected ion mode (SIM). Operating the TAGA in the MS mode under a variety of APCI conditions provides a fingerprint of the polluted air. In SIM mode, specific target compounds are continuously monitored in the real-time. The SIM mode is particularly useful for tracking plumes back to their source(s).

Operational control, data acquisition, and data reduction are facilitated by an on-board computer with 28 megabytes of storage. Air monitoring results are instantly displayed on a CRT monitor allowing the field scientist to access the data on-site and formulate the appropriate survey strategy.

The real-time detection limits vary greatly, depending on the contaminant, the CI reagent, and the sample matrix. Typical detection limits range from 0.1 ug/m^3 for amines to 100 ug/m^3 for aromatic compounds.

The analytical capabilities of the mobile air monitoring units are summarized in Table 1. Collectively the MAMUs are capable of monitoring a wide range of organic and inorganic pollutants, everything from SO_2 to PCBs. As shown in Table 1 there are distinct differences between the GC units (MAMU 1 and 2) and the mobile TAGA unit (MAMU 3). For instance, the GC units monitor the ubitquious pollutants, whereas the TAGA unit is most sensitive towards the uncommon pollutants. The MAMUs 1 and 2 are appropriate for measuring the less reactive, non-polar compounds. In contrast, the real-time monitoring capabilities of the MAMU 3 are ideal for the reactive pollutants. Thus the capabilities of the individual MAMUs compliment each other. When these units are used in conjunction, a comprehensive search for the volatile organics is possible.

TABLE 1

SUMMARY OF THE MAMU'S ANALYTICAL CAPABILITIES

TYPE OF COMPOUNDS DETECTED AT TRACE LEVELS

MAMUs 1 and 2	MAMU 3 (TAGA)
o classical pollutants (e.g. NO_2, CO, SO_2, TRS etc.)	o polar compounds including amines, amides, acids, aldehydes, alcohols, ketones, esters, phenols, sulfur species, chorinated aromatics, etc.
o C3 to C12 non-polar hydrocarbons including alkanes, alkenes, alkynes, aromatics and chlorinated hydrocarbons	

3.0 FIELD APPLICATIONS

The unique features of the MAMUs permit them to be applied to an assortment of environmental concerns, including the following:

- o assessing general air quality
- o identification of pollutant sources
- o chemical fingerprinting of odourous plumes
- o mapping (plume tracking) ground-level concentration
- o confirming the effectiveness of industrial abatement measures
- o emergency response to hazardous spills

In the discussion that follows a number of actual field studies are cited which exemplify the power of the mobile approach to air pollution monitoring.

3.1 Survey Strategy

Over the past 10 years, more than 120 air monitoring surveys have been conducted by the Monitoring Instrumentation and Development Unit of the Air Resources Branch. During this period, a systematic approach to air monitoring has evolved based on the unique strengths (and limitations) of the MAMUs and the accumulated experiences of the MAMU staff. Basically the survey strategy is to acquire and analyze representative air samples downwind of the suspected source(s). To isolate the source, upwind samples for background correction are also collected. Further delineation of the source is possible by correlating meteorological data with the ambient air quality data. On occasion, concurrent upwind and downwind air sampling by the MAMUs is performed in order to key on a particular source in a heavily industrialized area.

When planning and executing a definite survey strategy the following are considered.

- o type and description of environmental problem (e.g. emergency response, specific source or general air quality)
- o source inventory and production schedules
- o survey objectives
- o monitoring capabilities and resources
- o climatology
- o local topography and accessibility

A key advantage of using the MAMUs for pollution surveys is their ability to produce monitoring results in the field. The field scientists can then access the monitoring strategy and if necessary alter it to achieve the required survey objectives.

3.2 Example One: Waste Oil Refinery

In the first example, MAMU 1 was used in September 1985 to monitor a single source in rural central Ontario. The survey objective was to determine if the local air quality was affected by the installation of a new process technology at a waste oil refinery.

The ground level concentrations (glcs) were determined for a variety of common pollutants: CO, SO_2, TRS, NO_x, O_3 and THC. Air samples were screened for 125 hydrocarbons using the preconcentrator, dual-column GC techniques described earlier. In addition, a complete set of meteorological parameters were collected, including: wind speeds, wind direction, humidity, temperature and barometric pressure.

During the two week survey period more than 300 hours of common pollutants data and 31 ½-hour GC samples were acquired. The common pollutant data is summarized in Table 2. For all the common pollutants recorded ambient levels were enhanced downwind of the source. Only NO_x exceeded the Ministry Standard of 0.25 ppm; this was attributed to vehicle emissions and not the refinery.

The average number of volatile organics identified by the GC, downwind of the source, was 49. Table 3 is a detailed listing of the detected compounds. A comparison of the downwind and upwind monitoring results is summarized in Table 4. The dominant chemical classes were the alkanes and the aromatics with total average loading of 110 and 94 ug/m^3 respectively. There was a higher percentage of aromatic compounds in the downwind samples compared to the upwind samples. For all 29 downwind samples, none of the detected organics exceeded the applicable Ministry Standards or Guidelines.

Although the data base was small, the results of this survey indicated that the new technology installed at this waste oil refinery resulted in an improvement in the air quality as compared to data acquired for this same source a year earlier.

SUMMARY OF THE COMMON POLLUTANT DATA WASTE OIL REFINERY SURVEY (1985)

COMMON POLLUTANTS	UPWIND [1]MEAN	UPWIND [2]1/2 HR.	DOWNWIND MEAN	DOWNWIND 1/2 HR.
CO	0.54	1.42	1.20	8.53
TRS	0.001	0.001	0.004	0.008
SO_2	0.005	0.005	0.015	0.072
THC	1.44	1.67	2.31	7.08
TH-M	0.20	0.39	0.96	5.56
NO_x	0.03	0.09	0.07	0.30
O_3	0.01	0.03	0.02	0.07

[1] **Mean – Overall Arithmetic Mean Concentrations (ppm).**

[2] **1/2 HR. – Maximum 30-minute Concentrations (ppm).**

Table 2: Waste Oil Refinery Survey (1985) conducted by MAMU 1: common pollutant data.

Table 3: Waste Oil Refinery Survey (1985) conducted by MAMU 1: individual VOCs. Units of concentration are ug/m^3.

	Average	Maximum	Number of Samples
PROPANE	34.02	76.92	9
CHLOROMETHANE	0.68	0.68	1
2-METHYLPROPANE	4.69	11.98	18
1-BUTENE	4.64	7.56	4
1,3-BUTADIENE	1.23	1.61	2
BUTANE	11.86	31.10	27
3-METHYL-1-BUTENE	0.43	0.48	3
2-METHYLBUTANE	13.61	46.52	29
1-PENTENE	3.12	8.14	8
PENTANE	7.59	25.83	29
2-METHYL-1,3-BUTADIENE	1.60	3.13	8
TRANS-2-PENTENE	2.13	10.72	24
CIS-2-PENTENE	4.14	25.24	26
DICHLOROMETHANE	6.30	8.27	3
2-METHYL-2-BUTENE	4.73	28.57	26
2,2-DIMETHYLBUTANE	0.64	1.65	21
4-METHYL-1-PENTENE	0.47	0.47	1
3-METHYL-1-PENTENE	1.10	1.17	3
CYCLOPENTANE	0.98	2.18	15
2,3-DIMETHYLBUTANE	1.45	4.37	22
2-METHYLPENTANE	5.18	17.92	27
3-METHYLPENTANE	3.18	11.50	29
1-HEXENE	0.61	1.17	10
CIS-1,2-DICHLOROETHENE	1.88	1.88	1
2-CHLOROBUTANE	3.53	3.53	1
HEXANE	4.96	16.90	29
TRICHLOROMETHANE	5.44	8.50	2
TRANS-3-HEXENE	0.71	1.71	9
3-CHLORO-2-METHYLPROPENE	3.26	3.77	3
METHYLCYCLOPENTANE	2.08	8.09	27
1,1,1-TRICHLOROETHANE	4.37	9.50	3
BENZENE	14.94	87.19	28
CYCLOHEXANE	1.06	5.66	27
2-METHYLHEXANE	3.22	4.48	3
2,3-DIMETHYLPENTANE	4.38	25.98	28
CYCLOHEXENE	0.59	0.65	3
3-METHYLHEXANE	3.08	18.63	28
1,2-DICHLOROPROPANE	3.74	21.51	16
2,3-DICHLOROPROPENE	2.89	3.27	3
TRICHLOROETHENE	4.36	21.55	15
2,2,4-TRIMETHYLPENTANE	2.56	10.08	28
1-HEPTENE	0.50	0.50	1
HEPTANE	3.73	24.56	29
1-CHLORO-3-METHYLBUTANE	0.41	0.41	1
TRANS-2-HEPTENE	0.83	1.55	7

Table 3: ...continued...

METHYLCYCLOHEXANE	3.57	30.17	29
4-METHYLCYCLOHEXENE	1.64	7.44	21
2,5-DIMETHYLHEXANE	0.73	3.60	25
1-CHLOROPENTANE	1.08	1.58	2
TOLUENE	20.19	122.02	29
1,3-DICHLOROPROPANE	3.51	4.35	2
2-METHYLHEPTANE	1.14	2.81	13
4-METHYLHEPTANE	1.60	10.41	29
3-METHYLHEPTANE	0.96	0.96	1
1-OCTENE	1.66	4.28	6
TRANS12DIMETHYLCYCLOHEXAN	1.34	4.21	14
TRANS-4-OCTENE	1.28	2.56	3
TETRACHLOROETHENE	7.40	37.23	27
OCTANE	2.38	12.67	29
2-METHYL-1-HEPTENE	1.09	3.21	9
2-OCTENE	2.52	5.56	4
CIS12DIMETHYLCYCLOHEXAN	0.90	3.85	25
CHLOROBENZENE	1.02	2.57	13
ETHYLCYCLOHEXANE	0.87	5.20	24
PROPYLCYCLOPENTANE	1.29	7.72	24
ETHYLBENZENE	4.09	30.83	27
M-XYLENE	14.29	111.12	27
4-METHYLOCTANE	0.43	0.62	2
2-METHYLOCTANE	2.69	9.83	13
STYRENE	0.77	0.77	1
O-XYLENE	4.86	35.53	29
1,1,2,2-TETRACHLOROETHANE	3.86	5.75	5
1,2,3-TRICHLOROPROPANE	4.67	14.69	6
1-NONENE	1.85	7.30	9
NONANE	4.37	39.10	28
ISOPROPYLBENZENE	0.93	3.09	9
2-CHLOROTOLUENE	2.40	12.20	26
3-CHLOROTOLUENE	6.20	6.20	1
N-PROPYLBENZENE	1.95	14.82	26
4-CHLOROTOLUENE	3.20	19.31	18
3-ETHYLTOLUENE	3.58	31.05	27
4-ETHYLTOLUENE	3.36	17.44	19
1,3,5-TRIMETHYLBENZENE	4.47	37.83	16
2-ETHYLTOLUENE	1.78	5.58	18
tert-BUTYLBENZENE	8.89	74.37	28
1,2,4-TRIMETHYLBENZENE	45.52	45.52	1
1,3-DICHLOROBENZENE	1.98	1.98	1
1,5-DICHLOROPENTANE	0.84	0.84	1
DECANE	9.53	79.90	28
1,2,3-TRIMETHYLBENZENE	3.75	11.92	15
1ISOPROPYL4METHYLBENZENE	1.20	3.23	6
1,2-DICHLOROBENZENE	4.39	9.43	7
INDAN	2.19	11.09	20
N-BUTYLCYCLOHEXANE	1.44	3.46	17
1,3-DIETHYLBENZENE	0.78	1.02	2
1,4-DIETHYLBENZENE	2.92	10.92	14
N-BUTYLBENZENE	2.06	9.22	16
UNDECANE	10.30	73.88	29
DECAHYDRONAPTHALENE	2.11	10.62	28
1235-TETRAMETHYLBENZENE	4.84	28.90	25
1234-TETRAMETHYLBENZENE	3.76	19.64	23
DODECANE	8.45	42.28	25
Total Compounds Identifiec	49	70	29

SUMMARY OF GC DATA
WASTE OIL REFINERY SURVEY (1985)

	Downwind	Upwind
Total Compounds Identified	49	16.00
Total # of Peaks	122	32.00
Total Area of Peaks	8190.46	1956.43
Area of Identified Peaks	4839.26	1585.58
Area % Identified Peaks	63	79
Total Hydrocarbon ug/m_3	254.0	57.79
Alkanes ug/m_3	110.1	11.28
Cycloalkanes ug/m_3	11.1	2.52
Alkenes ug/m_3	16.3	1.72
Cycloalkenes ug/m_3	1.3	0.00
Alkynes ug/m_3	0.0	0.00
Aromatics ug/m_3	93.7	38.71
Chlorinated Alkanes ug/m_3	12.6	1.33
Chlorinated Alkenes ug/m_3	3.0	0.00
Chlorinated Aromatics ug/m_3	5.9	2.24

Table 4: Waste Oil Refinery Survey (1985) conducted by MAMU 1: Summary of GC results (Table 3).

3.3 Example Two: Kraft Pulp Mill

During September 1983, the mobile air monitoring units from the Air Resources Branch conducted an air quality survey at a kraft pulp mill in northwestern Ontario. The main objective of the survey was to characterize the total reduced sulfur (TRS) compounds being emitted from the main mill area and its secondary treatment system (lagoon).

This was the first attempt to operate the MAMU 2 and MAMU 3 together in a major TRS survey. Recently equipped with a new fluorescent-type analyzer, the MAMU 2 was used to monitor TRS. The MAMU 3 was to monitor individual components of the TRS parameter; namely, methyl mercaptan (MeSH), dimethyl sulfide (DMS) and dimethyl disulfide (DMDS). Sampling site locations were based on the plume tracking results of target compounds using the mobile TAGA unit, and the presence of sulfurous odours.

3.3.1 Kraft Pulp Mill

The TAGA mass spectra obtained downwind of the kraft pulp mill quickly revealed that the major TRS component was MeSH. An example of the real-time concentrations of MeSH while MAMU 3 drove past the mill on two consecutive streets is shown in Figure 3. Transferring the plume tracking data to a map, the source and plume boundaries are clearly visible (see Figure 4). Having located the plume and isolated the source, the MAMUs 2 and 3 then acquired ½-hour average concentrations of TRS and its individual components. The ½-hour concentrations of MeSH ranged from 14-81 ppb, always in excess of the Ministry Standard of 10 ppb. Half-hour average concentrations of DMS and DMDS were always less than 8 ppb. Areas within roughly 500 metres of the mill experienced TRS concentrations exceeding the TRS guideline of 27 ppb. Hydrogen sulfide (H_2S) levels were generally low, less than 10 ppb, except when the recovery boiler or lime kiln plumes impinged on the monitoring site. In this instance, the ½-hour H_2S concentrations approached 40 ppb.

3.3.2 Secondary Treatment System (Lagoon)

Air samples in the immediate vicinity of the lagoon were found to contain DMDS as the major TRS component. Hydrogen sulfide and DMS were comparatively minor components and MeSH was not detected. Shown in Figure 5 is an example of some plume tracking data for DMDS acquired by the mobile TAGA unit downwind of the lagoon.

P L U M E T R A C K I N G O F M E T H Y L M E R C A P T A N

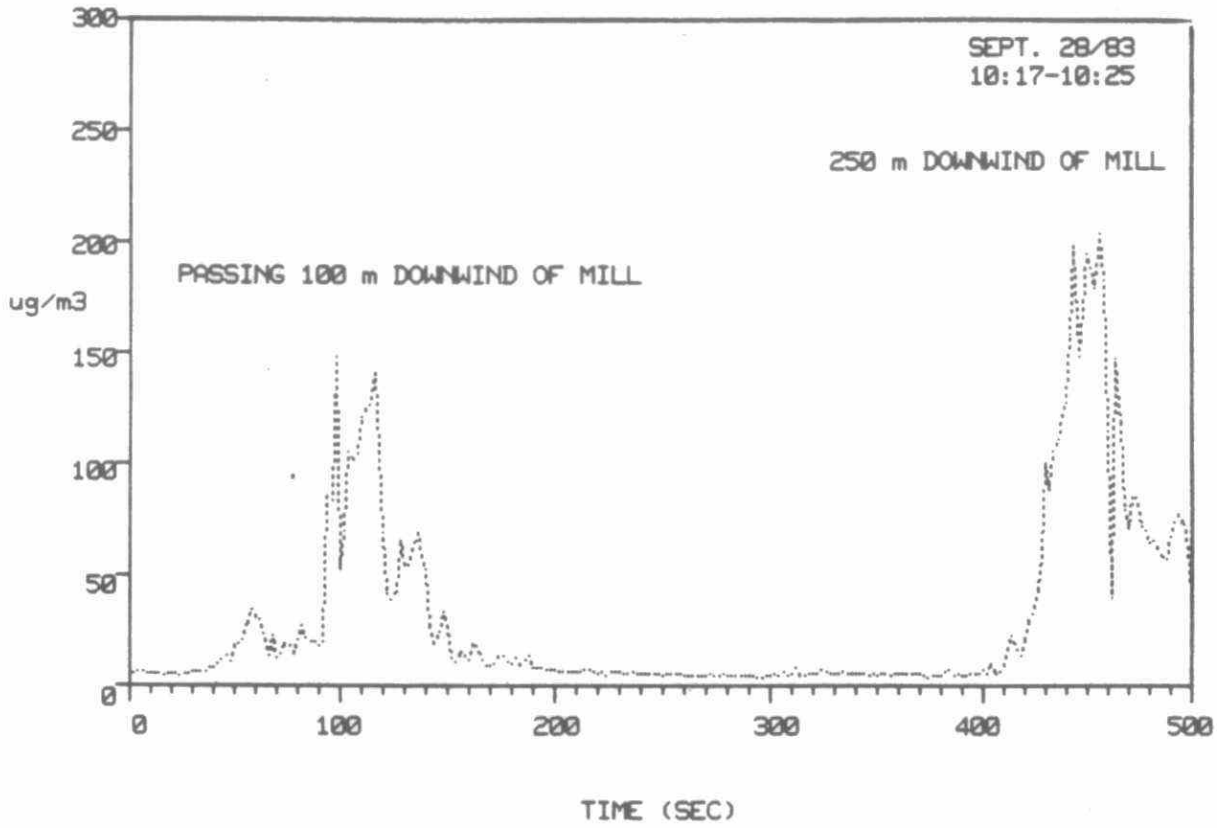


Figure 3: Kraft Pulp Mill Survey (1983). Real-time concentrations of MeSH acquired every 2 seconds while MAMU 3 passes downwind of mill on 2 consecutive streets.

METHYL MERCAPTAN ISOPLETHS

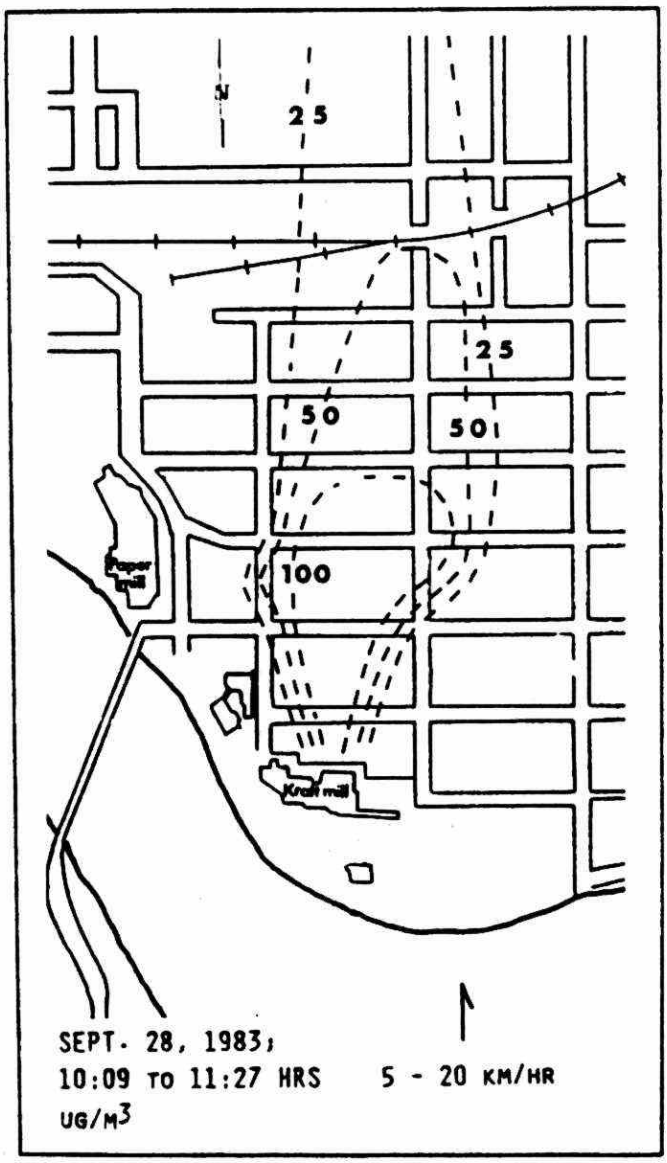


Figure 4: Kraft Pulp Mill Survey (1983). Concentration isopleths of MeSH showing plume boundaries and the source. (Scale: 1 cm = 100 metres).

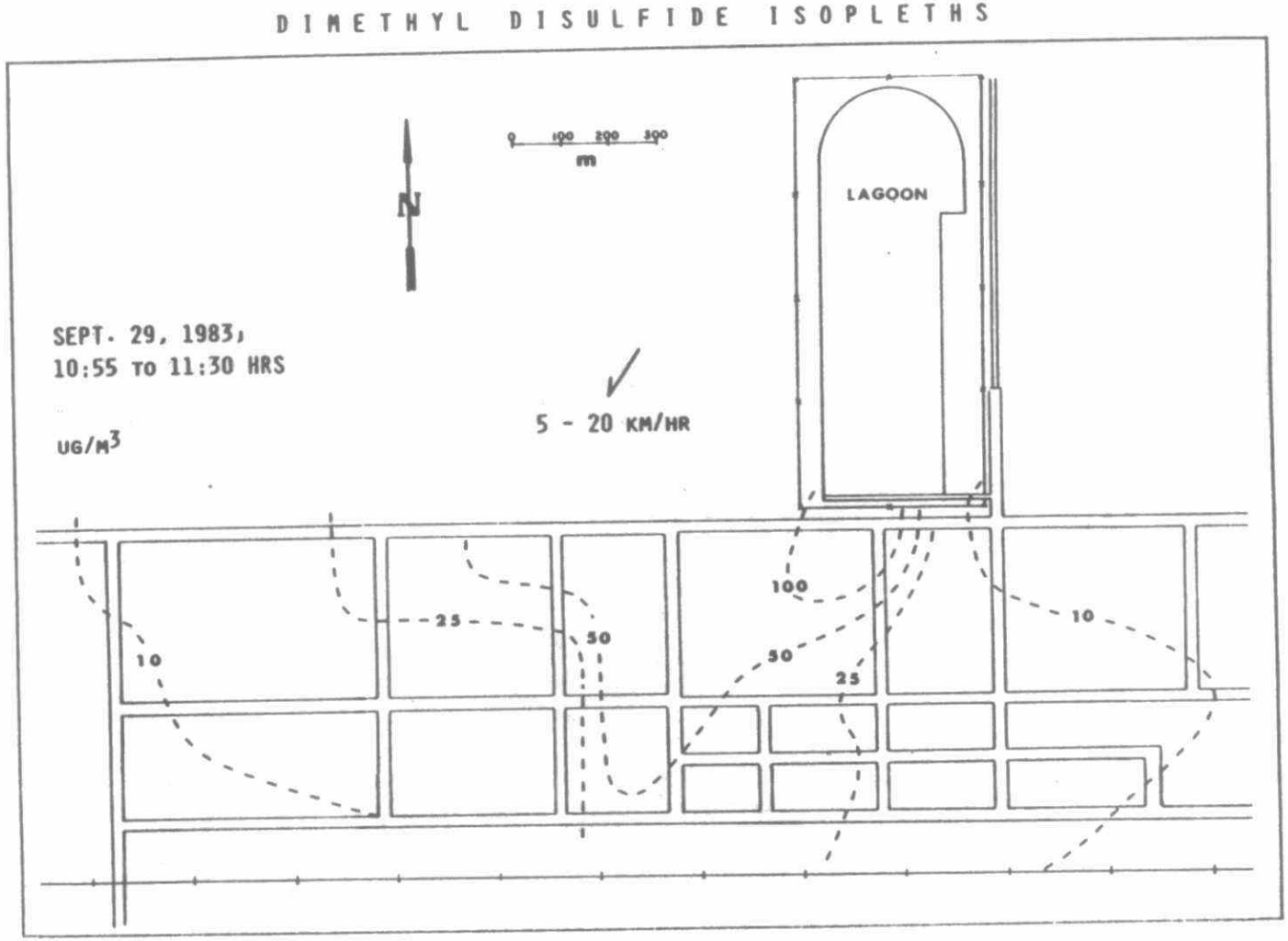


Figure 5: Kraft Pulp Mill Survey (1983). Concentration isopleths of DMDS downwind of the secondary waste treatment system (lagoon). Data were acquired by the mobile TAGA unit (MAMU 3).

The ½-hour average concentrations of the TRS components in the residential areas just downwind of the lagoon were: H_2S (1-8 ppb); DMS (2-6 ppb); DMDS (2-15 ppb); and TRS (4-28 ppb). The Ministry Standard of 10 ppb for DMDS was exceeded in 3 of 7 samples. For the other TRS components, Ministry Standards or Guidelines were not exceeded.

Thus the MAMUs 2 and 3 demonstrated that there were distinct differences in the TRS components at the two sources in question. A summary of the monitoring results are provided in Table 5.

In conclusion, the MAMU units offer a unique approach to the challenging task of monitoring volatile contaminants. The MAMUs are the most advanced analytical packages yet to be developed, far surpassing former techniques in their ability to gather vital on-site environmental information. Undoubtedly the applications of the MAMUs will expand as the technology advances and more environmental concerns are realized.

SUMMARY OF FINDINGS
KRAFT PULP MILL SURVEY (1983)

	Mill		Lagoon	
	Mean[1]	1/2 HR.[2]	Mean	1/2 HR.
H_2S	6	36	4	8
MeSH	39	81	NC[3]	NC
DMS	2	7	4	6
DMDS	<1	5	8	15
TRS	46	88	16	28

1. **Mean – Overall Arithmetic Mean Concentration (ppb).**
2. **1/2 HR. – Maximum 30–Minute Concentration (ppb).**
3. **NC – Not Confirmed Present**

Table 5: Kraft Pulp Mill Survey (1985). Summary of monitoring results. TRS and H_2S were measured by MAMU 2. MAMU 3 determined ambient levels of MeSH, DMS, and DMDS.

REGULATION 308 UPDATE

by J.M. Hewings and C.E. Duncan,
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INTRODUCTION

Ontario's legislation governing air management has evolved over the past 30 years. During that time the responsibility for ensuring the integrity of our air resource has been passed from municipal authorities to the Provincial Government, and the programs involved have been altered and refined on a number of occasions to deal with changing needs.

The current re-evaluation of Ontario Regulation 308 - General Air Pollution - represents one part of a further stage of refinement of the whole air management program designed to ensure that current needs are being addressed. The review which began in 1983 will involve:

- An examination of the history and philosophy of the Air Management Program.
- A total review of all the legislation governing air management - O. Reg. 308 is being examined in this context.
- An examination of the Design and Approvals process for air emissions.
- The development of policies and procedures related to source testing and control.
- A review of ambient air monitoring.
- An identification of research needs.

HISTORICAL BACKGROUND

The original Ontario General Air Regulation 449/67 was written under the authority of the Air Pollution Control Act 1967, the Act which granted the Province total jurisdiction in the control of air pollution.

Items of interest among the provisions of the original regulation, several of which remain in the existing regulation, were:

1. A requirement that all sources of an air contaminant shall not cause the maximum concentration, at a point of intersection between the plume and any significant object (the point-of-impingement), to be exceeded. The values used were calculated values recognizing plume rise and dispersion formulae.

2. The requirement that any failure of equipment to operate in a normal manner - resulting in the emission of air contaminants in greater quantity than is reasonable, be reported to a Provincial Officer, who was given the discretion to authorize continuance of the operation or impose conditions if considered necessary.

3. The prohibition of open fires except with the permission and under the direction, of a provincial officer.

4. The hours during which an apartment incinerator may be operated.

5. Provision for a table for the assessment of the level of air quality which should be maintained across the Province.

In 1970 the regulation was amended (O. Reg. 133/70) to accommodate the Air Pollution Index, a major control mechanism applicable under adverse meteorological conditions to prevent major air pollution episodes.

A major revision of the Regulation was undertaken in 1974 and for the first time the method of calculating the point of impingement was specified. The approved formulae contained in the Regulation were the Holland Plume Rise and the Pasquill Gifford equation for plume dispersion for general application, Scorer and Barrett for aerodynamic downwash, and the "Virtual Source" equation for use when emissions are being interfered with by the turbulent wake of buildings.

THE CURRENT REVIEW OF O. REG. 308

Background

Despite its generally acclaimed success as a mechanism for improving air quality in Ontario, while providing an acceptable basis for the approval of new or substantially altered sources of air emissions, the present legislative framework has been found to be inadequate to deal with a number of specific situations. Among these are:

- The long range transport of air pollutants.
- The accumulation of air pollutants through deposition.
- The control of emissions of black smoke by reference to smoke density charts.
- The method of regulating emissions of pollutants such as those with "non-threshold effects levels" including genotoxic, bioaccumulative as well as persistent compounds.
- The control of fugitive and low level emissions
- The modelling of complex plume situations.
- The appropriateness of the Air Pollution Index in its existing form.
- The use of guidelines for levels of contaminants in forage, soil, moss bags and snow.

Establishment of Internal MOE Working Groups

In order to address these items a technical review was initiated in November 1983 within the Ministry of the Environment. Eight working groups were established with the following specific tasks:

Working Group I - The co-ordinating group responsible for definitions and final recommendations.

Working Group II - Review of the Air Pollution Index (API) and alert procedures.

Working Group III - Responsible for a review of existing sections of Ontario Regulation 308 governing emissions to the atmosphere, examination of possible alternative methods of control or improvements to the existing framework, and the desirability of adding new objectives to deal with odours.

Working Group IV - Responsible for examining the possible inclusion of method to address long range transport of air pollution and the deposition of chemicals.

Working Group V - Responsibile for phytotoxicological aspects, in particular, levels of contamination in forage, foliage, soil, moss bags and snow.

Working Group IV - Evaluation of methods for determining the opacity of emissions and use of the visible emissions chart.

Working Group VII - Co-ordination of legislation pertaining to incineration.

Working Group VIII - Finalization of revised Regulation.

The Working Group's reviews were completed by the middle of 1985. Recommendations of the various groups were as follows:

Working Group I - It was recommended that the definitions for the following should be deleted:

(i) Fuel burning equipment (1d)
(ii) Highway (ie)
(iii) Incinerator (if)

It was found that the exemption under Section III for "fuel burning equipment used solely for the purpose of comfort heating" was covered in the Environmental Protection Act, and therefore redundant.

An exemption was recommended for a source of visible light radiation intended for the purpose of advertising.

o Working Group II

This Working Group recommended retention of the API in its existing format. The intentions of the MOE to introduce an Air Quality Index to supplement the Air Pollution Index as a means of public information on air quality was central to the Working Group's discussions.

It was noted in the discussion that the AQI:

- o Is not a legal instrument.
- o Was exclusively designed for public information and not control. (The API although currently used for both purposes is designed primarily as a control device.)
- o Is structured with descriptive terms.
- o Embraces contaminants which cannot be controlled.

Working Group III

After consideration of a number of alternative approaches to evaluating Certificates of Approval, this Group recommended adoptation of an approach currently used in the case of discharges to water.

Using this approach "best reasonable technology" would be demanded as the minimum acceptable level of control. Where circumstances, as indicated by ambient air quality modelling or the nature of the type of emission, demand it tighter controls to the point of minimum emission may be used. The group as part of its report recommended that the modelling provisions of the existing regulation be completely revamped, taking account of recent advances in the field, to permit total ambient modelling. In conjunction with this recommendation the Group advocated using the existing Ambient Air Quality Criteria as Ambient Air Quality Objectives. The existing half hour point of impingement standard under this system would be abolished.

Working Group IV

It became apparent that Group IV's mandate to investigate long range transport and deposition overlapped with tasks assigned to Group III. Accordingly, it was decided to merge the work of the two groups.

Working Group V

A uniform approach to the setting of guidelines in this area was evolved by the Working Group, but it was decided that these should be published as a guideline following review by the Environmental Air Standard Setting Committee rather than being incorporated into O. Reg 308 or O. Reg. 296.

Working Group VI

This Group recognizing obstacles encountered in producing a Visible Emission Chart, and the cost and general impracticability of alternatives, recommended that the wording of O. Reg. 308 should be changed to include reference to "trained observers" and that other changes should be made to enable such observers to operate effectively.

Working Group VII

Working Group VII concluded that there was potential for conflict between Ontario Regulation 308 and 309 on the subject of waste incineration. However at present no problem exists.

Air Pollution General Regulation Workshop

In order to subject the findings of the Working Groups to wider scrutiny and initiate further discussions, a workshop was held on November 14 and 15, 1985 at the Prince Hotel in Toronto. The workshop was attended by 60 invitees, chosen to represent the views of numerous interests including major industries, various levels of government, the academic community, non-government organizations (interest groups), consultants, equipment suppliers and envirnomental lawyers. A background document outlining the concerns and inadequacies of the existing regulation was mailed in advance to participants.

At the workshop there was an introductory session, three small group discussion sessions, and two plenary sessions at which workshop group facilitators reported back on the findings of their groups followed by question periods. To help participants understand the Ministry's aims, Air Resources Branch staff made a presentation on the modelling aspects of the review prior to the workshop sessions. The plenary sessions of the proceedings were taped and transcribed, and together with a review of the proceedings have been published. These are are available on request.

Workshop Conclusions

1. Use of Best Reasonable Technology and Ambient Modelling

Despite considerable support for the continued use of the point of impingement approach, there appeared to be a consensus that amendents or changes were indeed required to the Approvals process. Major areas of concern identified were:

- Long range transport.
- Accumulation of contaminants through wet and dry deposition.
- Emissions of genotoxic, bioaccumulative and persistent compounds.
- Multiple sources of emissions.

Given that to address these problems will entail some degree of bottom-of-the-stack control, the basic concept of using Best Reasonable or Best Available Technology did not appear to find disfavor. However, in terms of details, a number of practical problems were raised including:

- The way in which Best Reasonble or Best Available Technology would be defined.
- The phasing-in of the regulation.
- The use of worst case modelling.
- Possible disparities between Ontario and neighboring U.S sources.
- Different levels of control in different areas of the Province.
- Use of modelling in enforcement.

- o The interpretability of the Regulation by the courts and owners of emissions sources.
- o Whether the modelling should or should not be included in the regulation.

2. The Standard Setting Process

There was a clear request from a number of participants for a more accessible process for setting air quality criteria or objectives. The alternatives for greater public involvement which were discussed included better notice to the public on standard setting, more accessible documentation, and public hearings or some facility for public comment. A number of discussions identified a need for regular review of standards to ensure that they are based on most recent scientific evidence.

3. Certificates of Approval

Both the contents of Certificates of Approvals and the process by which they are issued were critically reviewed by the discussion groups.

On the contents of Certificate of Approval, a wide range of opinion was expressed. Many attendees were in favor of retaining the existing format, but others were insistent that changes were required. Nongovernment organizations in particular wanted much tighter controls on fugitive emissions and specific mention of housekeeping measures on Certificates, although the methods by which these might be achieved were not specified.

In terms of the process for granting C of As, the subject of hearings was discussed. Public hearings for "classes of C of A's" and the possibility of including hearings similar to those currently allowed at the discretion of the Director for certain waste management and disposal facilities (EPA Section 32(1)) were discussed.

The possiblity was also entertained that C of A's should be two-part documents with a C of A to contruct, and a C of A to operate, the latter to include process monitoring, compliance testing and reporting.

4. Opacity

On the question of opacity there was considerable support for the concept of using trained observers in lieu of smoke density charts, although there was some disagreement on details such as the frequency of personnel training and the possible direct involvement of the public.

The subject of whether the C of A should permit exemptions to opacity requirements under specific circumstances was raised. The use of time weighted averages, and a permitted number of violations emerged as suggested methods for addressing problem areas.

5. Air Quality Index

Many participants in the workshop expressed concerns over the Ministry's plan to retain the Air Pollution Index (API) for regulatory purposes while implementing the Air Quality Index as a public information device. The difficulty of having two paralled indices, the terminology involved, and the problems associated with high Air Quality Index values which could not be controlled by MOE (e.g. ozone) were identified as points of possible confusion.

The general concensus was that the API should be retained in its present form as a regulatory device designed to prevent health related air pollution episodes, while the AQI should become the prime public information index. It should be noted that the API is one of the terms included in the AQI, so to a limited extent there is some overlap in the two indices.

6. Phytoxicology Guidelines

Considerable constructive criticism of the phytotoxicology guidelines was expressed, particularly with regard to nomenclature and definitions. The concept of using the numbers was, however, generally supported and it was suggested that they might be incorporated in some way into the standard setting process.

7. Incineration, Open Burning, Wood Stoves

Support was expressed in the discussion groups for the creation of a separate guideline on incineration. Particular concern was expressed over Section 12 and its applicability to apartment incinerators, and over some of the terminology used in the regulation. Several participants advocated that destruction/removal efficiencies should be included in the regulation particularly to deal with emissions of hazardous contaminants. On the subject of open burning, municipal involvement based on a model by-law approach was favoured.

Woodstoves were identified as an item deserving of greater regulatory attention. The certification of approved designs was advocated.

TIMETABLE FOR THE REVIEW OF O. REG. 308

Attendees at the Workshop were asked to comment on the course of action which the government should follow in updating O. Reg. 308 combining these suggestions with M.O.E. requirements the following review process has been decided upon:

1. Workshop November 14 and 15, 1985.
2. Production of Proceedings and Summary Document General Air Pollution Workshop (Published March 1986).
3. Sixty day comment period.
4. Modelling workshop(s) concurrent with 3. Scheduled June 25, and 26.
5. Production of document by M.O.E. identifying rationale, direction and implications of proposals.
6. Circulation of rationale document to mailing list.
7. Sixty day comment period.
8. Production of Draft Regulation.
9. Circulation of Draft Regulation to mailing list
10. Sixty day comment period.

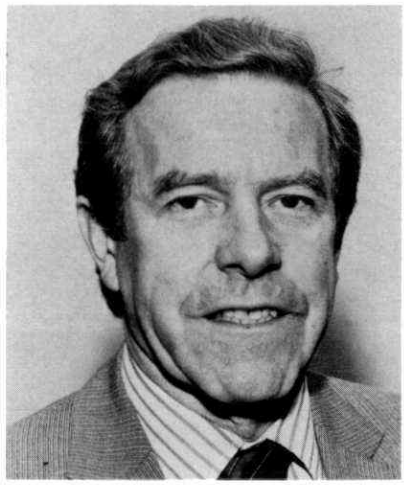
11. Discussions with Head Office and Regional staff on the proposed regulation.

12 Public meetings to discuss proposed regulation.

13. Production of Final Draft Regulation.

14. Send Regulation to Legislative Counsel for processing.

It is anticipated that these steps in the process will be completed by April 1987.



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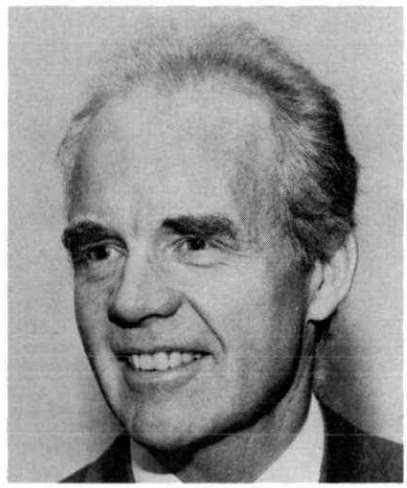

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CANADA/U.S. UPPER GREAT LAKES INTERCONNECTING CHANNEL STUDY

by V.V. Adamkus, Regional Administrator
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THE UPPER GREAT LAKES CONNECTING CHANNEL STUDY THAT I WANT TO TALK ABOUT TODAY IS USUALLY DESCRIBED AS A JOINT EFFORT AMONG THE U.S., CANADA, THE STATE OF MICHIGAN AND THE PROVINCE OF ONTARIO. SUCH A DESCRIPTION REMINDS ME OF A STORY:

TWO MOVING MEN WERE STRUGGLING TO GET A LARGE CRATE THROUGH A DOORWAY. THEY PUSHED AND TUGGED UNTIL THEY WERE EXHAUSTED BUT THE CRATE WOULDN'T MOVE. FINALLY THE MAN ON THE OUTSIDE SAID "WE'D BETTER GIVE UP, WE'LL NEVER GET THIS IN." TO WHICH THE MAN ON THE INSIDE REPLIED, "WHAT DO YOU MEAN GET IT IN I THOUGHT WE WERE TRYING TO GET IT OUT."

WELL, JOINT EFFORTS CAN SOMETIMES BE LIKE THAT. BUT I'M PLEASED TO REPORT THAT THE CONNECTING CHANNELS STUDY ISN'T.

THE UPPER GREAT LAKES CONNECTING CHANNELS CONSIST OF FOUR NAVIGATIONAL WATERWAYS: THE ST. MARY'S RIVER, THE ST. CLAIR RIVER, LAKE ST. CLAIR AND THE DETROIT RIVER. THE HIGH USE OF THESE CHANNELS COUPLED WITH THE HEAVY URBAN AND INDUSTRIAL DEVELOPMENT ALONG THEIR SHORES HAS RESULTED IN SERIOUS WATER QUALITY PROBLEMS . . . PROBLEMS WHICH WERE DETECTED AS FAR BACK AS THE 1940's WHEN CONTAMINATION BY MERCURY AND PHENOLS WAS RECORDED IN LAKE ST. CLAIR AND IN THE ST. MARY's RIVER.

IN 1981, THE INTERNATIONAL JOINT COMMISSION (IJC), CITING EVIDENCE OF CONTINUING DEGRADATION, LISTED THE ST. MARY's, ST. CLAIR, AND DETROIT RIVERS AS CLASS "A" AREAS OF CONCERN.

SINCE THAT TIME, WATER QUALITY IN THOSE AREAS HAS IMPROVED, ESPECIALLY AS IT RELATES TO CONVENTIONAL POLLUTANTS. BUT PERSISTENT POLLUTANTS LIKE HEAVY METALS, PESTICIDES AND PCB's REMAIN IN THE FISH, SEDIMENT, AND WATER COLUMN.

TO MEET THIS CONTINUING CHALLENGE, FORMER -- EPA ADMINISTRATOR WILLIAM RUCKELSHAUS ANNOUNCED IN 1983 A U.S. STUDY OF THE ST. MARY's, ST. CLAIR AND DETROIT RIVERS, INCLUDING LAKE ST. CLAIR. THIS EFFORT WAS QUICKLY JOINED BY STATE, PROVINCIAL, AND FEDERAL AGENCIES IN THE U.S. AND CANADA. THEIR COMMON GOAL WAS TO DETERMINE THE SOURCES, FATE, AND IMPACT OF TOXIC CONTAMINANTS RELEASED TO THE CONNECTING CHANNELS.

SINCE THE INCEPTION OF THE PROJECT, U.S. AND CANADIAN SCIENTIST AND ENGINEERS HAVE BEEN CONDUCTING A COMPREHENSIVE INVESTIGATION OF TOXIC CHEMICALS AND OTHER ENVIRONMENTAL CONCERNS IN THE CONNECTING CHANNELS. AT THE CONCLUSION OF THE STUDY (IN 1987), A SERIES OF RECOMMENDATIONS WILL BE DRAFTED OUTLINING WHAT SHOULD BE DONE TO REDUCE OR REVERSE THE SOURCES AND CAUSES OF CONTAMINATION, IMPROVE THE HEALTH OF THE SYSTEM, AND MONITOR THE EFFECTIVENESS OF THE CLEANUP PROGRAMS.

THE UPPER GREAT LAKES CONNECTING CHANNELS STUDY REPRESENTS, IN MICROCOSM, THE PROBLEMS AND THE SOLUTION WHICH BESET AND MUST BE APPLIED TO THE GREAT LAKES AS A WHOLE. RATHER THAN REHEARSING FOR YOU THE DETAILS OF THE CHANNEL STUDY, I WOULD LIKE TO SPEND THE BALANCE OF MY TIME TALKING WITH YOU ABOUT HOW THAT STUDY FITS INTO THE LARGER CONTEXT OF TOXICS CONTROL WITHIN THE GREAT LAKES.

OUR OBJECTIVE IS TO MAINTAIN A HEALTHY ENVIRONMENT AND A VITAL ROBUST ECONOMY. I BELIEVE THAT WE OWE BOTH TO THE PEOPLE OF OUR REGION . . . AND THEY, IN TURN, SEE THIS AS A BASIC RIGHT.

IT WAS NOT ALWAYS SO. IN THE PAST, JOBS OR A CLEAN ENVIRONMENT WERE SEEN AS MUTUALLY EXCLUSIVE. TODAY PEOPLE ARE MORE AWARE OF THE INTERRELATEDNESS OF THE QUALITY OF LIFE AND THE ENVIRONMENT. THEY NO LONGER PERCEIVE FULL EMPLOYMENT AND ENVIRONMENTAL QUALITY AS MUTUALLY EXCLUSIVE . . . INSTEAD THEY WANT BOTH.

THE HEART OF AMERICA'S INDUSTRIAL BASE IS HERE IN THE GREAT LAKES REGION. WE HAVE MANY OF THE SAME PROBLEMS COMMON TO OTHER INDUSTRIALIZED AREAS. BUT THE GREAT LAKES AREA HAS A SET OF PROBLEMS UNIQUE TO THEIR ENVIRONMENT. THE INDUSTRIES OF THE GREAT LAKES REGION FACE COMPETITION, NOT ONLY FROM ABROAD BUT FROM NEWLY DEVELOPING AREAS WITHIN THE UNITED STATES AS WELL . . . PRIMARILY THE SUN BELT. JUST THE NAME . . . THE SUN BELT IS IN

CONTRAST WITH SUCH NAMES AS THE RUST BELT, THE SNOW BELT AND THE FROST BELT, WHICH ARE REGULARLY APPLIED TO OUR REGION. THIS IMAGE OF COLD WEATHER INTRANSIGENT UNIONS, CRUMBLING CITIES, OUT-OF-DATE INDUSTRIES, AND OBSOLETE FACILITIES HAS BEEN A DETERRENT TO REVITALIZATION. COUPLED WITH THE OBVIOUS ENVIRONMENTAL CONSTRAINTS FROM THE TYPE AND EXTENT OF INDUSTRIALIZATION FOUND HERE, IT IS CLEAR THAT THE TASK OF ATTRACTING, MAINTAINING AND RENOVATING INDUSTRY AROUND THE GREAT LAKES WILL NOT BE EASY.

BUT THAT IS EXACTLY THE CHALLENGE WE FACE TODAY -- TO REVITALIZE AND PROMOTE INDUSTRY IN THE GREAT LAKES AREA WHILE SOLVING THE BIGGEST POLLUTION PROBLEM OF THE 80's, TOXIC CONTAMINATION. IT IS THE CHALLENGE IN THE CONNECTING CHANNELS, AS MUCH AS IT IS THROUGHOUT THE GREAT LAKES.

TOXIC POLLUTANTS ARE A RELATIVELY NEW PROBLEM. IN THE BRIEF SPAN OF TIME SINCE WORLD WAR II, TECHNOLOGY HAS BROUGHT US AN UNPARALLED PROFUSION OF NEW GOODS AND PROCESSES WHICH HAVE ENRICHED OUR LIVES. THEY HAVE RAISED THE STANDARD OF LIVING FOR THE AVERAGE PERSON AND MADE AVAILABLE A RANGE OF GOODS THAT ONCE ONLY THE RICH COULD AFFORD. IN MANY WAYS, THE PROMISE OF "BETTER LIVING THROUGH CHEMISTRY" HAS PROVEN TRUE.

BUT AS WITH ALL BENEFITS, THERE ARE SOME REAL COSTS. MANY OF THE BY-PRODUCTS OF THIS PROGRESS HAVE PRESENTED US WITH A SERIES OF NEW AND INSIDIOUS DANGERS THAT HAVE REQUIRED HIGH TECHNOLOGY ALL ITS OWN JUST TO UNCOVER.

THE EXTENT AND PERVASIVENESS OF THE DANGERS BECOME MORE OF A CONCERN EACH TIME WE TAKE AN ADDITIONAL STEP IN UNDERSTANDING THE DIMENSIONS OF THE PROBLEM. WE MUST SOLVE THESE TOXIC POLLUTION PROBLEMS. THE ENVIRONMENT DEMANDS IT, PUBLIC HEALTH DEMANDS IT, THE FUTURE DEMANDS IT.

MORE IMPORTANTLY, WE MUST SUCCEED HERE. THE LAKES HAVE PROBABLY THE LONGEST UNINTERRUPTED HISTORY OF CONTINUOUS USAGE OF ANY AREA IN NORTH AMERICA. WE HAVE A TREMENDOUS AND IRRETRIEVABLE INVESTMENT IN THIS AREA -- AN INVESTMENT OF CAPITAL, RESOURCES, CULTURAL AND HUMAN COMMITMENT THAT CANNOT BE WASTED OR EVEN BE ALLOWED TO DETERIORATE FURTHER.

I AM CONFIDENT OF OUR ABILITY TO MEET THIS CHALLENGE, BECAUSE WE HAVE FACED A SIMILAR CHALLENGE BEFORE . . . AND SUCCEEDED. IN THE 1960's AND 70's WE MOVED TO CONTROL THE INFUX OF CONVENTIONAL POLLUTANTS TO THE GREAT LAKES. AND, IN THIS WE HAVE A GREAT ENVIRONMENTAL SUCCESS STORY. THERE HAVE BEEN, AS THE RESULT OF OUR EFFORTS, DRAMATIC IMPROVEMENTS IN BIOLOGICAL OXYGEN DEMAND, SUSPENDED SOLIDS, ENTERIC INDICATOR ORGANISMS, AND NUTRIENTS IN WATER, ALONG WITH REDUCTION OF AMBIENT CONCENTRATIONS OF PARTICULATES AND SULFUR DIOXIDE IN AIR.

THIS WAS DONE THRU THE COMBINED EFFORT OF MANY LEVELS OF GOVERNMENT, PRIVATE INDUSTRY, AND INDIVIDUAL PEOPLE.

WE CONTROLLED AIR EMISSIONS, BUILT SEWAGE TREATMENT PLANTS, BANNED PHOSPHORUS DETERGENTS, AND CONTROLLED DISCHARGES OF NUTRIENTS AND WASTES. CLASSIC EXAMPLES OF ENVIRONMENTAL CLEANUP ARE THE CUYAHOGA RIVER AND LAKE ERIE. THE CUYAHOGA FREQUENTLY CAUGHT FIRE, AND LAKE ERIE WAS SO EUTROPHIED THAT MANY WERE GIVING UP ON IT -- CALLING IT A DEAD LAKE. TODAY, THERE ARE FISH IN THE CUYAHOGA, AND LAKE ERIE HAS THE LARGEST COMMERCIAL FISHERY IN THE GREAT LAKES.

BUT AS GRATIFYING AS THESE SUCCESSES HAVE BEEN, THEY DO NOT SIGNAL THE FINAL VICTORY OVER POLLUTION. WE ARE NOW FACED WITH A SECOND GENERATION CHALLENGE -- TOXIC AND HAZARDOUS SUBSTANCES. THEY ARE PARTICULARLY DIFFICULT PROBLEMS. THERE ARE MANY SOURCES AND MANY WAYS THAT THESE SUBSTANCES CAN ENTER THE LAKES AND ENVIRONMENT. THEY CAN COME FROM THE AIR AND BE DEPOSITED BY PRECIPITATION. THEY ARE OFTEN DIRECTLY DISCHARGED TO STREAMS AND RIVERS OR INDIRECTLY DISCHARGED BY LEAKING LANDFILLS AND UNDERGROUND TANKS, OR RUNOFF FROM FIELDS AND STREETS. CONTAMINATED SEDIMENTS AND THEIR SLOW RELEASE OF IN-PLACE TOXIC SUBSTANCES ARE OF GRAVE CONCERN.

TOXIC SUBSTANCES ARE ALSO AN EXTRAORDINARY PROBLEM BECAUSE OF SEVERAL CHARACTERISTICS BEYOND THEIR NUMEROUS SOURCES. THERE ARE SO MANY OF THEM -- DIFFERENT CHEMICALS WITH DIFFERENT CHARACTERISTICS. THE POTENTIAL FOR CHEMICAL

REACTIONS, INTERACTIONS, AND SYNERGISM, EVEN FURTHER COMPLICATES AN ALREADY CLOUDED PICTURE. WE ARE JUST NOW BEGINNING TO LEARN WHAT TO LOOK FOR AND HOW TO LOOK FOR THEM. MANY OF THESE SUBSTANCES ARE FOUND AT THE LOWER LIMITS OF DETECTION, AND MEASURING THEM REQUIRES SOPHISTICATED AND EXPENSIVE MEASUREMENT TECHNIQUES. BUT, IT IS IMPORTANT TO ADVANCE WITH THE TECHNOLOGY TO MAKE SUCH FINE MEASURES, BECAUSE MANY OF THESE TOXIC SUBSTANCES CAN CAUSE SERIOUS HEALTH AND ENVIRONMENTAL EFFECTS AT VERY MINUTE CONCENTRATIONS.

MANY OF THESE TOXIC SUBSTANCES ARE ALSO REMARKABLY STABLE. THEY CAN PERSIST IN THE ENVIRONMENT, UNCHANGED, AND WAITING TO CAUSE PROBLEMS, OFTEN FOR YEARS. SOME TOXIC SUBSTANCES BIOACCUMULATE, WHICH RAISES THEIR CONCENTRATION BY MANY MULTIPLES, AS THEY MOVE UP THE FOOD CHAIN.

ALL OF THESE FACTORS BEAR UPON THE NEED TO CONTROL THESE TOXIC SUBSTANCES, AND WE ARE NOT FAR ALONG THAT LEARNING CURVE. WE NEED TO DEVELOP BETTER WAYS TO ASSESS HEALTH EFFECTS FROM EXPOSURE TO TOXIC SUBSTANCES, AS WELL AS TO DEVELOP BETTER WAYS FOR ASSESSING POTENTIAL HAZARDS OR RISKS FOR INDIVIDUAL PRODUCTS, PROCESSES, AND CHEMICALS. THEN, WE NEED TO EVOLVE WAYS TO CONTROL THESE HAZARDS AND MOVE THEM FROM THE ENVIRONMENT.

THE UPPER GREAT LAKES CHANNEL STUDY IS AN EXPERIMENT. THE TECHNIQUES WE EMPLOY, THE RELATIONSHIPS WHICH WE FORGE HERE WILL BE EXPANDED AND IMPLEMENTED THROUGHOUT THE GREAT LAKES.

THE REALIZATION OF THE PLANS AND DREAMS OF OUR PEOPLE DEPENDS ON OUR ABILITY TO RESTORE AND PROTECT OUR RESOURCE BASE. WE DO NOT SEEK TO TURN THE GREAT LAKES INTO SOME ARTIFACT OR WILDERNESS PRESERVE.

WE SEEK TO RESTORE THE AREA TO ECONOMIC PROSPERITY BY GUARANTEEING THE HEALTH OF OUR RESOURCE BASE. . . OUR LAKES AND OUR PEOPLE.

THIS IS THE CONTEXT AND THE CHALLENGE OF THE UPPER GREAT LAKES CHANNEL STUDY.

CAN THIS JOB BE DONE? I THINK IT CAN BE. WE HAVE ALREADY FACED SUCH A CHALLENGE BEFORE WITH CONVENTIONAL POLLUTANTS. WE'RE WINNING THAT BATTLE, AND MANY OF THE LESSONS LEARNED THERE CAN BE TRANSFERRED TO OUR NEW CHALLENGE.

SHOULD WE DO IT? I FEEL IT IS IMPERATIVE THAT WE DO SO. WE, AS A NATION, HAVE TOO MUCH INVESTED IN THE GREAT LAKES AREA TO LET IT DETERIORATE.

WILL WE DO IT? I HAVE NO DOUBTS THAT WE WILL.

PERCHLOROETHYLENE SPILL CLEAN UP ON THE ST. CLAIR RIVER

by D. A. McTavish, Director, Southwest Region, Environment Ontario, London

Background

Between August 13 to 16, 1985 approximately 9400 gallons of perchloroethylene, a dry cleaning chemical produced by Dow Chemical Canada Inc. escaped from a truck loading area. It was estimated that 2500 gallons of the spilled material reached the river with approximately 2000 gallons being recovered shortly after the incident. Puddles of the perchloroethylene were noted in an area offshore from Dow where a depression in the river bed was evident. The area of contaminated sediment was determined to be in a square approximately 150' by 150'.

One year earlier, in August of 1984 a diver for the University of Windsor observed a puddle of dark tar-like material in approximately the same area of the 150' square. The University of Windsor was carrying out studies on the river and the diver obtained a sample of the material that he had observed. In September of 1985, the analysis of the sample collected by the diver was made available to the Ministry of the Environment. The analysis indicated the presence of dioxin and this information was immediately released to the public. At about the same time, September 1985, a MOE diver confirmed the presence of puddles in approximately 25' of water offshore from Dow. The area containing the puddles was confirmed by Dow to be in an area 150' by 150' and the company proceeded to grid the area with ropes attached to the river bottom to assist in pinpointing the location.

Media coverage of the spill, the dark tar-like puddles, and the presence of dioxin in the sample taken one year earlier, suddenly exploded.

Dow Proposal

On October 23, Dow Chemical Canada Inc. provided a proposal for clean up and presented it to the Ministry of the Environment. The proposal contained the following elements:

1. Because of visual evidence of perchloroethylene (perc) the company proposed to remove the loose perc contaminated sediment in the area.

2. The area for sediment removal was defined by 150' by 150' area and indicated by a rope grid staked to the river bottom. The average depth of sediment was estimated to be 6" and therefore approximately 450 cubic yards of sediment was anticipated to be the amount to be removed.

3. A high powered vacuum truck located on a barge on the river was to remove material, discharge it to a barge, the barge was to go to shore, a second vacuum truck was to remove the material from the barge and transport it to a pond on the company's property.

4. Sampling was proposed a) one sample upstream of the work area, b) two samples approximately 1000' directly downstream from the work area, c) three samples along a transect at the company's south boundary, d) one sample from an existing station south of Courtright. These samples were to be analysed by the company for perc and the results made available to the MOE prior to starting the next day's work.
The criteria suggested for the monitoring program was a) one day concentration of 2300 ppb perc not to be exceeded at the southern Dow boundary, b) ten day concentration of 175 ppb perc not to be exceeded at the southern boundary, and c) seventy year World Health Organization criteria of 10 ppb perc in drinking water was not to be exceeded at any of the drinking water intakes.
The proposal also included treatment of the material stored in the pond and involved steam striping to remove the perc and recycle it and landfilling of residue to the company's Scott Road landfill site. It was further indicated that the operation was anticipated to take approximately two weeks with the treatment of the removed material to take place over an eight or nine month period.

MOE Approval

The proposal from Dow was reviewed by the Ministry and circulated to other agencies for comment. The agencies circulated included the Michigan Department of Natural Resources, and the Environmental Protection Agency. Following these reviews, the Ministry in a letter dated November 8, 1985 approved the company's proposal subject to a number of conditions including: 1) the work was to be done in accordance with the requirements of the Ministry of Labour, 2) the sampling program was to include the following a) one sample to be taken 1000' upstream of the work area, b) at a transect 1000' downstream from the work area samples were to be collected at a lateral distance of 25', 125', and 225' from shore with samples to be collected every two hours, starting one hour before the work start up for the

first three operating days, with those samples being analysed for perc, c) samples were to be collected at Dow's south boundary and analysed for perc, and d) one sample was to be taken from the station at Courtright. 3) The removal of material was to stop at the direction of the MOE if monitoring indicated the criteria had been exceeded or if additional information was required by the MOE. The approval also indicated that 1) an MOE diver would be observing the clean up work as it progressed, 2) temporary facilities for treating with powdered activated carbon would be available at Walpole Island and Wallaceburg and these facilities would be placed in operation during the clean up, 3) air samples would be collected in the area of the storage pond, 4) bore hole results had been obtained from the proposed storage pond and these confirmed the integrity of the pond, 5) information on the daily sampling would be provided to the Medical Officers of Health, municipalities and the Michigan Department of Natural Resources, and 6) samples of raw, untreated water would be collected at Wallaceburg and Walpole Island during the clean up period. In addition, at the request of the Town of Marysville in Michigan, the Ministry was to analyze samples of water from that treatment plant as well. A portable laboratory was set up at the Corunna Sewage Treatment Plant and manned by MOE laboratory technicians.

The Clean Up

Dow commenced removal of the contaminated sediment on November 14. Divers started work with the vacuum head developed for the clean up work but found it necessary to modify the head and other portions of the operation to get the optimum efficiency from the equipment. The work took much longer than anticipated, being completed on December 23 with the actual numbers of days of vacuuming being 28. The costs were also much higher as a result of the greater effort required and these costs approximated $1 000 000. The work took longer because a) there was a need to alter the equipment particularly during the start up, b) there were several weather related days, c) there was an unexpected high amount of sediment, and d) there was a higher than expected water to sediment ratio. All of these problems were overcome while meeting the water quality conditions layed down by the Ministry of the Environment.

Monitoring

The Ministry of the Environment and Environment Canada joined forces to monitor the clean up and also to complete a more wide spread study resulting in the production of a joint report entitled "St. Clair River Pollution Investigation (Sarnia Area)". This report was released during January of 1986.

The Ministry of the Environment monitored water quality at the water treatment plants at Wallaceburg, Walpole Island, and Marysville. The results of analysis of samples collected on one day were reported on the following day. Over 1500 samples were analysed for perc by Dow and the MOE including some of those for cross checking purposes. All of the samples of raw water at the treatment plants during the clean up phase were less than one part per billion, which was the detection limit i.e. none detected.

Environment Canada used an underwater camera to monitor the clean up operation. This piece of equipment proved to be very valuable and assisted Dow in selecting the most effective vacuum head for its vacuum equipment. The camera was most useful in assessing the efficiency of the clean up and was used following the clean up operation to determine if puddles had been missed. The camera also confirmed that only one to two per cent of the 150' square was covered with puddles, and is currently being used in assessing the effectiveness of the revacuuming.

The Ministry of the Environment sampled on a transect approximately 4000' down river from the clean up area and its results were compared to those of Dow sampling on a daily basis. Most of the water samples collected from the river were below 10 ppb (10 ppb is the World Health Organization's limit for drinking water used over a 70 year period). The samples taken closest to shore tended to have the higher perc concentration. A small percentage of the samples in the river close to shore exceeded the 10 ppb.

Communications

A very major effort was required in keeping people informed during the clean up operation. The high profile the project had in the media increased this need for accurate information.

Dow held a major press conference prior to the clean up beginning and also met with local municipalities and appeared at an inquiry held by U.S. Congressman David Bonior in Michigan.

The Ministry of the Environment conducted a major program of communications during and after the clean up. This program was assisted by staff from Environment Canada and involved technical briefings of the various agencies (U.S. and Canadian) and separate briefings for citizens groups, elected officials from the immediate area (provincial, state, federal, and municipal). In addition to the meetings called by the Ministry, staff were involved in attending local council meetings and meetings of citizens groups. In addition MOE and Environment Canada staff were also present at the inquiry held by the Congressman and two

public meetings in the United States. Contact with the news media was also intense during this period and during the initial stages staff from the MOE's Communication Branch were stationed in Sarnia to assist in this aspect of communication.

One of the most intense programs of the communications approach was that of advising the municipalities downstream of Sarnia, the U.S. Coast Guard (who in turn advised the other U.S. interests), the MOH's and the Walpole Indian Band on a daily basis of all the results of the analytical work and the progress of the clean up. These contacts were made on a daily basis, seven days per week, during the clean up phase.

This massive effort on communications proved to be very effective in keeping the various parties well informed as the work progressed and also involving them in the debriefing following the project.

Aftermath

The clean up of the perchloroethylene puddles has accelerated work at Dow with respect to its sewer separation program and all of its efforts in the environmental control area. Revacuuming has been required on approximately a monthly basis with the volume of material being removed lessening as time goes on. Another vacuuming is scheduled for June and an assessment of any additional work that may be required will be made this summer.

The most likely cause of repuddling is thought to be that of perchloroethylene migrating from the gravel like deposits in the river bed which were not removed by vacuuming.

The Ministry of the Environment has expedited the implementation of its MISA program (Municipal and Industrial Strategy for Abatement). This program will require sampling and analysis for a wide range of parameters on a regular basis and will also outline detailed control levels for the wide range of parameters. These requirements will be in the form of regulations and pilot work on the monitoring is now underway and does involve some of the Sarnia based companies.

The reporting of spills has greatly increased as has the awareness of the need to take all reasonable steps to avoid or lessen spill incidence.

The perchloroethylene spill and clean up has drawn considerable attention to the problem of toxic and hazardous wastes in our waters in general, and to the Sarnia area in particular. It has heightened public awareness and caused

the public to demand more stringent controls of discharges. It has been a catalyst for industry, government, and society to direct more resources to address the concerns of toxic compounds in the Great Lakes.

NEW DIRECTIONS FOR INDUSTRIAL AND MUNICIPAL WASTEWATER CONTROL IN ONTARIO

by P. Crabtree, Assistant Director, Water Resources Branch, Environment Ontario, Toronto

The author based his talk on a June 1986 White Paper entitled " Policy and Program Statement of the Government of Ontario on Controlling Municipal and Industrial Discharges into Surface Waters".

Copies of the White Paper are available on request to the Ontario Ministry of the Environment, Water Resources Branch, 4th. Flr., 1 St. Clair Ave., West, Toronto, Ont., M4V 1K6, Att. P.J. Crabtree.

ENVIRONMENTAL PROGRAM FOR THE DEVELOPMENT OF A GOLD MINE

by M. Wiber, Environmental Scientist,
Noranda Inc., Toronto, Ontario

MY PRESENTATION TO YOU THIS MORNING DEALS WITH THE OVERALL ENVIRONMENTAL PROGRAM FOR THE DEVELOPMENT OF NORANDA'S GOLDEN GIANT MINE NEAR MARATHON, ONTARIO. STUDIES ON THE PREVAILING ENVIRONMENTAL CONDITIONS, SUITABLE WASTE DISPOSAL SITES, AND WASTE WATER TREATMENT REQUIREMENTS WERE CARRIED OUT. PUBLIC INFORMATION SESSIONS WERE HELD IN COMMUNITIES IN THE VICINITY OF THE MINE. BEFORE GOING INTO THE DETAILS OF THE PROGRAM I WOULD FIRST LIKE TO DESCRIBE THE ENVIRONMENTAL ASPECTS OF A MINING PROJECT AND THE TYPES OF WASTES GENERATED BY THE MINING AND MILLING PROCESS.

OREBODIES ARE DEVELOPED BY UNDERGROUND OR OPEN PIT MINING METHODS. MINE WASTE IS GENERATED WHEN ROCK SURROUNDING OR OVERLAYING THE DEPOSIT IS REMOVED IN ORDER TO GAIN ACCESS TO THE ORE. THE QUANTITIES OF MINE ROCK GENERATED WILL VARY DEPENDING UPON THE SPECIFIC NATURE OF THE MINE. IN OPEN PIT MINING, THE ROCK IS GENERALLY DEPOSITED ADJACENT TO THE PIT. WITH UNDERGROUND MINING METHODS, MINE WASTE CAN OFTEN BE USED UNDERGROUND IN BACKFILL. THE QUANTITIES OF ROCK REMOVED IN ORDER TO ACCESS THE OREBODY ARE USUALLY MUCH SMALLER FOR AN UNDERGROUND MINE COMPARED TO OPEN PIT METHODS.

AT THE GOLDEN GIANT MINE, UNDERGROUND MINE METHODS USING BACKFILL ARE BEING USED.

MINE WATER IS GENERATED WHEN THE WATER TABLE IS INTERCEPTED AS THE MINE IS DEVELOPED AND, IN THE CASE OF OPEN PIT MINING, PRECIPITATION AND RUN-OFF IN THE PIT AREA ARE SOURCES OF ADDITIONAL INPUTS. THE QUALITY OF THE MINE WATER WILL BE DIFFERENT FOR EVERY MINE AND WILL DEPEND ON THE TYPE OF ROCK SURROUNDING THE OREBODY AND THE TYPES OF MINERALS WITHIN THE OREBODY ITSELF. MINE WATER IS PUMPED TO THE SURFACE TO PREVENT FLOODING OF THE MINE WORKINGS. THE OXIDATION OF EXPOSED SULPHIDE MINERALS, MAINLY IRON SULPHIDE OR PYRITE, CAN CAUSE A DROP IN PH AND LEACHING OF HEAVY METALS INTO MINE WATER. MINE WATER ALSO CONTAINS SEDIMENT FROM DRILLING AND BLASTING OPERATIONS.

AT HEMLO, THE MINE WATER IS PUMPED TO A WATER TREATMENT PLANT ON SURFACE FOR PH ADJUSTMENT IF REQUIRED AND SEDIMENT REMOVAL.

THE ORE IS BROKEN AND CRUSHED TO A FINE SAND TEXTURE. FURTHER PROCESSING METHODS USED WILL DEPEND ON THE MINEROLOGY AND METALS TO BE EXTRACTED FROM THE ORE. IN THE PROCESS USED AT HEMLO FOR GOLD EXTRACTION WATER IS ADDED IN THE GRINDING STAGE TO FORM A SLURRY OF SAND AND WATER. LIME, FOR PH CONTROL AND CYANIDE, TO LEACH OUT THE GOLD, ARE ADDED TO THE SLURRY. LEACHING TANKS PROVIDE APPROXIMATELY 3 DAYS RESIDENCE TIME TO THOROUGHLY LEACH THE GOLD OUT OF THE ORE AND INTO SOLUTION. OTHER TRACE ELEMENTS MAY ALSO LEACH OUT OF THE GOLD AT THIS STAGE AND, AT HEMLO, THESE INCLUDE ANTIMONY, IRON, ZINC, COPPER AND NICKEL.

THE SLURRY SOLUTION, LOADED WITH DISSOLVED GOLD, IS THEN PUMPED TO TANKS CONTAINING ACTIVATED CARBON WHERE THE GOLD IS ADSORBED. THE LOADED CARBON AND SLURRY ARE SEPARATED. THE GOLD IS STRIPPED FROM THE CARBON AND REFINED FURTHER USING ELECTROWINNING TECHNIQUES TO PRODUCE A GOLD BAR. THE SLURRY GOES ON TO THE MOLYBDENUM CIRCUIT FOR REMOVAL OF MOLYBDENITE. AT THIS TIME FURTHER TESTWORK IS NEEDED TO FULLY DELINEATE THE FLOWSHEET FOR MOLYBDENUM SEPARATION AND THE CIRCUIT OPERATES ONLY ON A TEST BASIS.

THE REMAINING SLURRY, CALLED TAILINGS IS PUMPED TO THE BACKFILL PLANT. THE COARSE FRACTION OF THE TAILINGS, ROUGHLY 35-40% IS USED FOR BACKFILL IN THE MINE. THE REMAINING TAILINGS ARE PUMPED TO THE TAIINGS DISPOSAL FACILITY WHERE THE SANDS SETTLE OUT AND A POND FORMS. THIS POND, OR DECANT WATER, IS RECLAIMED FOR USE IN THE MILL WHERE POSSIBLE. THE EXCESS WATER IS TREATED IN THE EFFLUENT TREATMENT PLANT BEFORE DISCHARGING TO THE ENVIRONMENT.

IN SUMMARY, LIQUID EFFLUENTS AND SOLID WASTES FROM MINING AND MILLING PROCESSES THAT REQUIRE SURFACE DISPOSAL ARE THE MAJOR CONCERNS AT HEMLO AND MOST OTHER MINING AND MILLING OPERATIONS. A SUMMARY OF THE FATE OF THESE WASTES AT HEMLO IS AS FOLLOWS:

MINE WASTE - TO BE USED UNDERGROUND AS BACKFILL
MINE WATER - TREATED IN THE EFFLUENT TREATMENT PLANT
TAILINGS - 40% BACKFILL, 60% TO DISPOSAL FACILITY
DECANT - USED AS RECYCLE IN THE MILL OR TREATED IN THE EFFLUENT TREATMENT PLANT.

ADDRESSING ENVIRONMENTAL CONCERNS

TAILINGS DISPOSAL

DUE TO THE RELATIVELY LARGE VOLUME OF TAILINGS TO BE DISPOSED OF, THE SELECTION OF A SUITABLE TAILINGS SITE WAS A MAJOR CONCERN.

THE SELECTION OF THE SITE WAS PRECEDED BY A REVIEW OF ALL POTENTIAL AREAS IN REASONABLE PROXIMITY TO THE MINE. THE MAIN CRITERIA USED TO EVALUATE THE SUITABILITY OF EACH SITE INCLUDED:

1. ENOUGH ULTIMATE CAPACITY FOR THE ANTICIPATED LIFE OF THE MINE;

2. CONTAINMENT WITHIN A SMALL WATERSHED AREA TO LIMIT THE AMOUNT OF RUN-OFF TO THE SITE;

3. GOOD SITE STABILITY;

4. MINIMUM IMPACT ON EXISTING LAND USES AND

5. REASONABLE DISTANCE TO THE PLANT SITE.

THE SITE FINALLY CHOSEN IS LOCATED 2.8 KM TO THE NORTH WEST OF THE MINE IN A BASIN SHAPED VALLEY WITH AN AREA OF ABOUT 140 HA.

CONTAINMENT OF THE TAILINGS WILL OCCUR BEHIND THE MAIN (EAST) DAM AND TWO SMALLER DAMS LOCATED TO THE WEST AND SOUTH SIDES OF THE BASIN. INITIALLY, TO PROVIDE STORAGE FOR THE FIRST 3 YEARS OF OPERATION, ONLY THE MAIN EAST DAM (28M) WAS BUILT. AS THE BASIN FILLS WITH TAILINGS THE MAIN DAM WILL BE RAISED TO A HEIGHT OF 45 M AND THE WEST (12 M) AND SOUTH (5 M) DAMS ADDED. PREPARATION OF THE SITE INCLUDED REMOVAL OF THE TREES AND GRUBBING OF THE INITIAL AREA OF THE TAILINGS FACILITY AND POND.

TO MINIMIZE THE RATE OF SEEPAGE THROUGH THE DAM, SPECIAL TECHNIQUES WERE USED IN CONSTRUCTION. FIRST, THE GRANULAR SOILS ALONG THE UPSTREAM TOE OF THE DAM WERE CLEARED DOWN TO BEDROCK. A CEMENT GROUT CURTAIN EXTENDING TO A DEPTH OF 10 METRES INTO BEDROCK WAS PROVIDED TO SEAL CRACKS IN THE UPPER LAYER. A LOW PERMEABILITY ARTIFICIAL HDPE LINER (2 MM) WAS ANCHORED TO THE BEDROCK AND PLACED OVER THE MAIN DAM ON A SAND BEDDING. COMPACTED TILL WAS THEN PLACED OVER THE LINER AND FINALLY RIP-RAP WAS PLACED TO PREVENT EROSION. THE BARRIER ON THE UPSTREAM SIDE OF THE DAM CONSISTING OF THE LINER, ANCHOR AND GROUT CURTAIN PROVIDES A CONTINUOUS LOW PERMEABILITY ZONE THAT WILL MINIMIZE SEEPAGE THROUGH THE DAM.

AN ADDITIONAL MEASURE TO REDUCE THE SEEPAGE FLOW THAT WOULD REPORT TO CEDAR CREEK IS THE SEEPAGE COLLECTION FACILITY. MOST OF THE SEEPAGE THAT BYPASSES THE MAIN DAM WILL FLOW ALONG THE PREFERRED PATHWAY IN THE SURFICIAL SOILS AND UPPER LAYER OF BEDROCK. A SECOND LOW PERMEABILITY BARRIER WAS THEREFORE INSTALLED ALONG THE BASE OF THE MAIN DAM. A CUT-OFF TRENCH WAS EXCAVATED INTO ROCK AND CEMENT GROUTING WAS PROVIDED TO DIRECT SEEPAGE INTO THE SEEPAGE COLLECTION DITCH AND INTO THE POND. THE CONSTRUCTION TECHNIQUES EMPLOYED AT THE SEEPAGE COLLECTION DAM WERE THE SAME AS THOSE FOR THE MAIN DAM.

ANY WATER COLLECTED IN THE SEEPAGE COLLECTION FACILITY IS PUMPED BACK INTO THE TAILINGS POND.

THE EFFLUENT

A TREATMENT SYSTEM FOR REMOVAL OF CYANIDE AND HEAVY METALS TO BELOW ONTARIO MINISTRY OF THE ENVIRONMENT (MOE) GUIDELINES HAD TO BE DESIGNED. THE MAIN PARAMETERS OF CONCERN IN THE WASTE WATER THAT WAS STUDIED INCLUDED CYANIDE, COPPER, IRON, ANTIMONY AND ZINC.

THE EFFLUENT TREATMENT PLANT, ALTHOUGH IN OPERATION FOR LESS THAN A YEAR, IS MEETING MOE GUIDELINES. THE FINAL DESIGN IS A TWO STEP PROCESS. A FLOATING RECLAIM PUMPHOUSE DIRECTS DECANT WATER TO THE MILL SITE. PART OF THE WATER IS RECYCLED DIRECTLY TO THE MILLING PROCESS WITH THE BALANCE REPORTING TO A TWO STAGE EFFLUENT TREATMENT PLANT. THE FIRST TREATMENT STAGE INVOLVES DESTRUCTION OF CYANIDE. A MAJOR PORTION OF THE CYANIDE FREE WATER WILL BE RECYCLED AND USED TO WASH BACKFILL SANDS. THE EXCESS WATER TOGETHER WITH MINE WATER REPORTS TO A SECOND WATER TREATMENT STAGE WHERE HEAVY METALS ARE PRECIPITATED WITH FERRIC SULPHATE. THE TREATED WATER IS DISCHARGED VIA A PUMPING STATION AND PIPELINE TO THE WHITE RIVER WATERSHED. A SUMMARY OF OPERATING DATA FROM JANUARY TO APRIL 1986 FOR THE MAIN PARAMETERS OF CONCERN FOLLOWS:

EFFLUENT TREATMENT PLANT DATA

	pH	TOTAL CYANIDE	COPPER	IRON	NICKEL
INFLUENT	9	20-50	5	7	5
EFFLUENT	7.5-9.5	<2	<.1	<1	<.1
MOE GUIDELINE	5.5-10.6	2.0	*	1	*

AVERAGE FLOW RATE FOR JAN-APRIL 1986 = 190 m^3/hr OR 700 Igpm

*TOTAL CONCENTRATION OF HEAVY METALS (CU, ZN, NI AND PB) NOT TO EXCEED 1 MG/L

ENVIRONMENTAL MONITORING PROGRAM

ENVIRONMENTAL BASELINE MONITORING WAS CONDUCTED IN TWO WATERSHEDS DUE TO THE TREATED EFFLUENT DISCHARGE LOCATION. THE STUDY AREAS INCLUDED CEDAR CREEK, IMMEDIATELY ADJACENT TO THE PLANT SITE IN THE BLACK RIVER WATERSHED AND DOWNSTREAM OF LIM LAKE IN THE WHITE RIVER WATERSHED. A THIRD AREA AT THE CONFLUENCE OF THE BLACK AND PIC RIVERS WAS ADDED DUE TO CONCERNS FOR THE BLACK RIVER AS THE DRINKING WATER SOURCE FOR THE HERON BAY BAND.

DATA WAS COLLECTED ON SOILS, SEDIMENTS, FISH SPECIES PRESENT, MERCURY LEVELS IN FISH FLESH, BENTHOS AND WATER QUALITY IN THESE AREAS. IN THE CEDAR CREEK/BLACK RIVER AREA WHITE SUCKERS (20), NORTHERN PIKE (6), YELLOW PERCH (5) AND YELLOW WALLEYE (5) WERE COLLECTED. MERCURY LEVELS IN WALLEYE TAKEN FROM BLACK RIVER RANGED FROM .5-.9 UG/G (.67 UG/G MEAN). THE HEALTH AND WELFARE CANADA (HWC) GUIDELINE FOR HUMAN CONSUMPTION IS 0.5 UG/G.

FISH COLLECTIONS IN THE MOLSON/HAYWARD LAKE SYSTEM INCLUDED NORTHERN PIKE, YELLOW WALLEYE, WHITE SUCKER, YELLOW PERCH, LAKE WHITEFISH AND CISCO. AS FOR THE BLACK RIVER WALLEYE, MERCURY LEVELS FOR WALLEYE IN HERRICK AND HAYWARD LAKES TENDED TO EXCEED THE HWC GUIDELINE. THESE LEVELS ARE NOT UNUSUAL FOR FISH TAKEN FROM REMOTE LOCATIONS.

THE PRE-OPERATIONAL BASELINE REPORT WAS FILED WITH THE MINISTRY OF ENVIRONMENT AND WILL ALLOW COMPARISONS WITH DATA COLLECTED DURING THE ONGOING COMPLIANCE MONITORING PROGRAM AND FUTURE AQUATIC SURVEYS.

PUBLIC INFORMATION SESSIONS

AT THE OUTSET OF OUR DISCUSSIONS WITH ONTARIO MINISTRY OF ENVIRONMENT OFFICIALS, THE IMPORTANCE OF THE HEMLO MINING DEVELOPMENT WAS RECOGNIZED. IT WAS DECIDED THAT, AS PART OF THE PERMIT APPROVAL PROCESS, A THOROUGH PUBLIC INFORMATION EFFORT WOULD BE REQUIRED FOR THE AFFECTED COMMUNITIES.

OPEN HOUSES AND PUBLIC INFORMATION SESSIONS WERE HELD IN THE NEIGHBOURING COMMUNITIES OF MOBERT, HERON BAY, MARATHON, WHITE RIVER AND MANITOUWADGE. THE PURPOSE OF THE PUBLIC SESSIONS WAS TO ENSURE THAT COMMUNITY CONCERNS WOULD BE ADEQUATELY ADDRESSED IN THE ENVIRONMENTAL CONTROL PROGRAM. PUBLIC CONCERNS CENTERED ON THE BLACK RIVER DRINKING WATER SUPPLY, THE FISHERIES, LONG TERM STABILITY OF THE TAILINGS DAM FACILITY AND THE ABILITY OF GOVERNMENT TO MONITOR THE MINING OPERATION FOR COMPLIANCE WITH THE EFFLUENT GUIDELINES AND APPROVED OPERATING PRACTICES. THESE PUBLIC CONCERNS ARE REFLECTED IN THE SPECIAL TECHNIQUES USED TO CONTROL SEEPAGE FROM THE TAILINGS AREA, THE EFFLUENT DISCHARGE LOCATION AND THE TERMS AND CONDITIONS OF THE CERTIFICATE OF APPROVAL THAT REQUIRE RIGOUROUS MONITORING AND REGULAR REPORTING; AND PLANS FOR DECOMMISSIONING THE PLANT SITE AND TAILINGS FACILITY PRIOR TO CLOSURE.

ENVIRONMENTAL ASSESSMENT AND PROJECT APPROVALS

AN IMPORTANT COMPONENT OF THE ENGINEERING AND APPROVALS PROCESS WAS THE PREPARATION OF AN ENVIRONMENTAL ASSESSMENT REPORT. IT WAS PREPARED IN ORDER TO EVALUATE THE ENVIRONMENTAL IMPACT OF THE MINE DEVELOPMENT ON THE BLACK RIVER AND WHITE RIVER WATERSHEDS. THE FOCUS OF THE ASSESSMENT REPORT WAS ON WATER QUALITY AND FISHERIES. IN THE EARLIEST STAGES OF THE PROJECT DESIGN AND THROUGHOUT THE PROJECT DEVELOPMENT, WHEN ALTERNATIVE ENGINEERING DESIGNS WERE BEING ASSESSED, ENVIRONMENTAL IMPACTS WERE CONSIDERED ALONG WITH COST AND DESIGN ASPECTS. THE FINAL ENVIRONMENTAL ASSESSMENT DEALT ONLY WITH THE FINAL DESIGN CHOICES. THE DOCUMENT WAS FILED WITH THE MOE REGIONAL OFFICE IN THUNDER BAY.

WITHIN THE REQUIREMENTS OF THE ONTARIO WATER RESOURCES ACT AND POLICY OF THE MOE FOR APPROVING MAJOR INDUSTRIAL PROJECTS, THE ENVIRONMENT ASSESSMENT REPORT AND LOCAL COMMUNITY MEETINGS WERE VALUABLE ELEMENTS OF THE APPROVAL PROCESS. THE OVERALL APPROACH SEEMED TO WORK. A CRITICAL CHARACTERISTIC WAS THAT THE TIMING OF EVENTS WAS ESSENTIALLY DRIVEN BY THE PROPONENT AND THE PROJECT REQUIREMENTS. THE PROCESS WAS FLEXIBLE AND RESPONDED DIRECTLY TO THE ENVIRONMENTAL CONCERNS SPECIFICALLY RELATED TO THE PROJECT.

NUMEROUS STUDIES PROVIDED THE NECESSARY BACKGROUND FOR THE ENVIRONMENT ASSESSMENT REPORT AND INCLUDED;

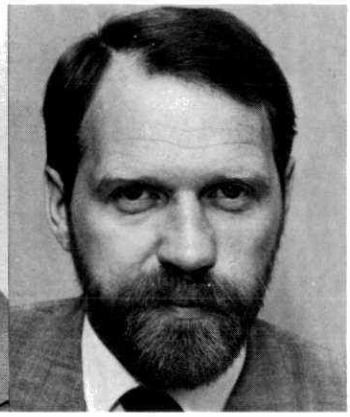
- METALLURGICAL TESTING AND WASTEWATER QUALITY ANALYSIS;
- WASTEWATER TREATMENT TESTWORK;
- ENGINEERING AND PROCESS DESIGN;
- GEOTECHNICAL EVALUATIONS AND TAILINGS DAM DESIGN;
- TAILINGS AREA SEEPAGE ANALYSIS AND LONG TERM PROJECTIONS; AND
- ENVIRONMENTAL BASELINE STUDIES.

CLOSING REMARKS

THE PROJECT DID NOT SUFFER ANY DELAYS, YET THE ENVIRONMENTAL REVIEW AND SAFEGUARDS WRITTEN INTO THE FINAL APPROVAL VIGOUROUSLY PROTECTS THE PUBLIC INTEREST. THIS DEMONSTRATES THE POSSIBILITY OF PROPER ENVIRONMENTAL ASSESSMENT WITHIN A TIMEFRAME FLEXIBLE ENOUGH TO AVOID UNNECESSARY DELAY TO THE UNDERTAKING. OUR EXPERIENCE SUPPORTS AN APPROACH THAT PROVIDES THE MINISTRY WITH THE FLEXIBILITY TO DETERMINE THE EXTENT OF ENVIRONMENT ASSESSMENT REQUIREMENTS AND PUBLIC INVOLVEMENT ON A SITE-SPECIFIC BASIS, ENSURING THAT NON-ENVIRONMENTAL ISSUES DO NOT JEOPARDIZE AN UNDERTAKING AND THAT DETAILED ASSESSMENT WORK BE CARRIED OUT FOR SIGNIFICANT AREAS OF POTENTIAL IMPACTS ONLY.

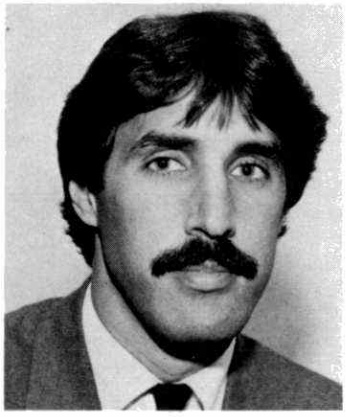
Moderator: Ivy Wile,
Acting Director,
Intergovernmental Relations &
Hazardous Contaminants Branch,
Environment Ontario, Toronto

R. Redhead,
Market Development Manager,
Tricil Ltd., Mississauga, Ontario,



W. Armstrong,
Energy Pathways,
Ottawa, Ontario

B. Singh, Manager,
Abatement West,
Central Region,
Environment Ontario, Toronto



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W.P. Torbet, Manager,
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D. Erskine, Chair,
Pottersburg Creek Pollution
Committee and Alderman,
City of London, Ontario

ON-SITE: A NEW APPROACH TO INDUSTRIAL WASTE MANAGEMENT

by R.J. Redhead, Tricil Ltd., Mississauga,
and W. Armstrong, Energy Pathways, Ottawa

I'd like to tell you about an exciting project in which Tricil is actively involved. It's called "On-Site" and many of you have probably already heard of it. For those who haven't, On-Site will be placing 100 young professionals in Ontario companies to help them improve their waste management practices. The salaries of these project workers are paid for 6 months using federal job creation funds. At the end of the project, the companies can hire the project workers if they wish.

Any one of the On-Site representatives here will be pleased to talk to you about this project. What I'd like to do in the short time I have today is to explain a bit more about On-Site and why Tricil is supporting it, as well as bring you up-to-date on the project's progress.

On-Site is a new approach to industrial waste management. It was developed four years ago by Energy Pathways, an Ottawa consulting firm and test marketed in Ontario. They saw that government wanted industry to improve its waste management, but needed a more positive approach than just applying tighter and tighter regulations. The solution that Energy Pathways came up with was On-Site -- an approach that not only reduces pollution, but also creates jobs and saves money for industry. In fact, everyone comes out ahead.

Energy Pathways has tested the On-Site approach in pilot projects in Ontario and Nova Scotia. The results were impressive. In both cases, participating companies made improvements to their waste management practices and saved money -- enough that most of the firms hired their project workers on as permanent employees with ongoing waste management responsibilities. Last year, Tricil provided Energy Pathways with the financial support needed to develop a full-scale On-Site project in Ontario.

You may ask why Tricil is supporting On-Site. We feel that this sort of positive approach to waste management is long overdue. Too often, government and industry are in conflict over waste management issues. The public believes that industry has to be forced to improve environmental management. In fact, the waste management industry, in which Tricil is a major player, plays an important role in environmental protection in this province. Projects like On-Site developed by private sector companies and supported financially by both industry and government, help make the public aware that industry <u>is</u> approaching waste management in a constructive fashion and that government and industry can work together.

Though tougher regulations have signalled the end of thoughtless pollution, regulations alone will not stop all waste. No one wants to see environmental progress equated with plant closings and lost jobs. Unfortunately, this can occur if industry doesn't use available resources to analyze problems and create solutions benefiting both the environment and themselves. A project like On-Site gives companies the tools to make the most of their waste management opportunities.

Since 1973, Tricil has been helping Ontario industry deal with wastes by providing safe and efficient disposal services. But, over the years, our definitions of waste and waste management have broadened. True wastes are things with no further use, that must be discarded. However, many companies produce wastes that could be prevented, reused or recycled. Like everyone here, Tricil wants to see this kind of waste reduced. On-Site provides a way of doing this.

We have heard from the Minister of the Environment about the importance of protecting Canada's waterways from pollution. On-Site helps reduce pollutants being discharged to the environment by assisting companies in identifying sources and implementing new waste management techniques.

But On-Site does a lot more than prevent pollution. There are many unemployed or underemployed professionals in Canada. Most are young people who haven't been able to get the kind of position for which they are qualified. They are caught in the trap of "no experience, no job -- no job, no experience." On-Site helps them break out of that trap. As a major player in the waste management industry, Tricil is committed to helping young science and engineering graduates get started in the essential waste management profession.

The key to On-Site's impact is the attention given to pre-project planning and consultation. Months before this project started, Energy Pathways and Tricil were contacting government departments and industry associations for recommendations on companies who could benefit from the services On-Site has to offer. Universities, colleges and professional associations were also contacted in order to find potential employees. We were also in touch with research organizations and technical specialists in government and industry, lining up experts to participate in employee training sessions.

By the time the project officially started early this year, when funding for On-Site employees' salaries were approved by Employment and Immigration Canada, networks for the supply of labour, the market and technical support were well in place.

Briefly, the process of recruiting and matching companies and employees is as follows. Companies recommended for involvement by industry associations or other members of the labour market network are contacted by an On-Site representative. These representatives work out of the main project office in Port Credit and satellite offices in Kitchener-Waterloo, Sarnia, St. Catharines and Kingston. They brief companies on On-Site and explain its benefits. Interested companies are assisted in preparing job descriptions outlining what they would want their project worker to do.

Meanwhile, other On-Site representatives work with Canada Employment centres and universities, building up a pool of qualified candidates who meet the eligibility requirements of the program. When a job description is received from a company, this pool is searched for candidates who meet the requirements, the resumes of these candidates are sent to the company and the company decides who they wish to interview. The company conducts the interviews and decides who they want to hire.

Once hired, the On-Site project worker is treated like any other member of the company. However, they have the added advantage of On-Site's training and technical support program. Each On-Site worker reports to one of five field supervisors, who provide technical assistance and monitor the employees' progress. In addition, all On-Site workers attend five-day training seminars, organized jointly by Tricil and Energy Pathways, where they learn up-to-date analysis and treatment techniques and problem-solving methods as well as the latest information on regulations.

This whole aspect of regulations is particularly important. In truth, Ontario industry does not have a waste management problem -- if performance is measured against existing standards. However, the call today is for better standards. Tricil has always supported government in its quest for stronger regulations to protect the environment, and we also encourage more stringent enforcement of these regulations. At the same time, we recognize the burden that complying with new regulations can place on companies. By training On-Site workers in the ins and outs of Regulation 309, the Transportation of Dangerous Goods Act and other pertinent regulations, we are helping waste generators understand and comply with them.

What companies who join On-Site get, therefore, is a carefully selected, trained waste manager who is backed up by an impressive network of technical and administrative support. Having such a person on the plant floor can make a world of difference to companies that are faced with new regulations but don't know where to start in terms of managing their wastes. This is particularly true in smaller companies in which day-to-day production crises can consume all available staff time.

In small companies, having someone who can devote six months to analyzing the waste system can make all the difference. Many companies don't realize how much they are spending on poor waste management. The real costs of waste are hidden in inventory losses, water and energy charges, surcharges, excessive maintenance, transportation and insurance charges.

Company management may think that the cost of modifying procedures to reduce waste at source, or of investing in new treatment equipment, is not justified when compared with disposal charges. But when somebody -- the On-Site worker -- takes the time to document the real costs of poor waste control, almost invariably the company finds it saves money by tightening up on wastes. In more cases than not, these savings more than pay for the cost of hiring the On-Site worker at the end of the project.

Thus, in just six months, an On-Site worker can shift a company's thinking from "waste disposal" to "waste management", a change in attitude that has profound implications for environmental improvement.

As of last week, 22 companies had hired On-Site workers. They include food and beverage processors, chemical manufacturers, metal finishing operations, textiles producers, plastics manufacturers and general manufacturers. Another 15 companies are interviewing candidates and 50 have supplied job descriptions. In all, more than 200 companies have been contacted and briefed on the project, but there is still room for interested companies who want to apply.

More than 230 candidate employees have been identified and the pool is still growing. Once again, there is still room for engineers and technicians who meet the requirements -- technical training and eligibility for unemployment insurance benefits. Over 100 project workers will be on the job by the end of the summer. The project itself is scheduled to end in December of this year, but an expanded On-Site project is already in the works for next year.

On-Site is only part of waste management training and communications activities at Tricil. Through projects like On-Site, Ontario industry is demonstrating that the private sector, in cooperation with government, can not only manage its wastes, but also improve productivity and create meaningful employment.

DECOMMISSIONING, CLEANUP AND RE-USE OF INDUSTRIAL SITES

by B. Singh, Central Region, Environment Ontario, Toronto

Introduction:

The subject of this paper was originally Decommissioning of plant sites; however, since decommissioning is usually undertaken with re-use in mind, and is invariably associated with cleanup to remove contaminants from previous use, cleanup and re-use have been introduced. The paper deals with the expanded title - Decommissioning, Cleanup and Re-use of Industrial Sites.

Decommissioning - A Growing Activity:

The following statement is on Page (ii) of the Guide to Environmental Aspects of Decommissioning Industrial Sites, May 1985 prepared by Monenco for Environment Canada

> "it is estimated that during the years 1984 to 1990, approximately 20% of existing Canadian industrial capacity will be shut down for economic reasons. This massive plan closure program will be brought about largely by the obsolescence and age of industrial facilities ...".

This startling statement, if true, can only mean that, in June 1986, we are busily engaged in decommissioning, cleanup and re-use activities. My experience since the end of 1983, supports this statement and my colleagues in the Ministry tell me that decommissioning activities are on the increase in other regions of Ontario.

This rapid growth in decommissioning activities has caught engineers, scientists and industrialists unprepared. Our education and professional practices

have been focused on building and operating facilities with little thought about decommissioning and dismantling. Control agencies, such as the Ministry of the Environment, have developed standards and have approval systems for works that are being constructed. Very little formal mechanisms exist to cater for the shutdown of facilities.

MOE Guidelines:

Towards the end of 1983, the Central Region of the Ministry became involved with a major decommissioning at the Shell refinery in Oakville. Resulting from this activity, the Ministry published "Guidelines for the Decommissioning (Shutdown) of Major Industrial Sites in Ontario" in June 1984. The document advised that anyone faced with the decision to shutdown an operation should commence early discussions with the Ministry to determine what would be required. The document does not state what to do and how to carry out the exercise; it directs the decommissioner to what would be needed to develop specific requirements for adequate and satisfactory decommissioning.

The primary concerns are on-site contamination and possible offsite migration; possible health hazard or damage to the environment; adequate cleanup to ensure safety of future users of the property; and proper protection to workers and neighbouring citizens during actual shutdown, dismantling and cleanup.

Successful decommissioning requires in-depth background knowledge of past operations; changes in use of the site; changes in products and materials used; past waste disposal practices especially on-site waste disposal. Information on these may be obtained from company and municipal historical records, newspapers of the period and retired employees.

The guideline directs attention to the following: on-site waste treatment facilities which may have to be continued until final closure; attention to changes in loading and strengths of wastes being treated; hydrogeological and soil investigations; safe disposal of materials; decontamination of equipment and recycled hardware; air quality during dismantling and consolidation of waste; on-site supervision; future land usage involving constraints or restrictions on title that may be necessary.

This document with six pages of text is being revised; in keeping with the growth of this activity, the prepared draft is now over 36 pages. The revised document should be available later this year and will include some cleanup criteria for soils. Table I is a reprint of proposed criteria. Pending issuance of the revised guidelines, users should check with the local ministry office before using this table.

Federal Guide:

The Federal document mentioned earlier was aimed specifically at the oil, gas and chemical industries. It has many more pages (187 pages) than the Provincial guidelines yet it contains the following statement

> "while the guide identifies and describes in detail the activities associated with the planning and implementation of a cost effective program, it is not a blue print - a program must be designed to address individual site conditions. The approach to decommissioning must be flexible and responsive to specific site condition".

This statement on the need to develop site specific programs emphasizes a well recognized characteristic of decommissioning - site specificity. The guide contains case histories of the decommissioning of a lead acid battery plant, a refinery site and a sour gas processing plant. The document discusses the following factors: decommissioning planning, plant site assessment, site investigations, cleanup criteria, site cleanup, confirmatory analysis, long term monitoring, regulatory agency involved, public involvement and preventive measures.

Federal Provincial Industrial Initiative:

The documents by Environment Ontario and Environment Canada demonstrate recent attention to decommissioning by these two agencies. On the initiative of Mr. Art Stelzig of Environment Canada "to get something done" on a national basis, to develop a consistent uniform approach across the country, a Steering Committee comprising Federal, Provincial and Industrial representatives was established in the Spring of 1985.

TAPLE 1

Clean-Up Criteria For Soils

Parameter	Criteria for Proposed Redevelopment[1]		
	Agriculture[2]	Residential/ Parkland[3],[4]	Commercial/ Industrial[3],[4]
pH	-	6-8	6-8
EC(mS/cm)	-	2	2
SAR	-	15	15
Arsenic	14	25	50
Cadmium	1-6	4[3a]	8[3a]
Chromium (6+)	-	10	10
Chromium (total)	120	1000	1000
Copper	100	300	300
Lead	60	500[3a]	1000[3a]
Mercury	0.5	1[3a]	2[3a]
Molybdenum	4	5[3b]	40
Nickel	32	200	200
Nitrogen (%)	-	0.6	0.6
Oil and Grease (%)	-	1[5]	1[5]
Selenium	1.6	5[3b]	-
Silver	-	25	50
Zinc	220	800	800

Notes:

1) All units in ppm unless otherwise stated.

2) Refer to Ontario's Guidelines For Sewage Sludge Utilization On Agricultural Lands, available from Ministry of the Environment.

3) Clean-Up criteria recommended by Phytotoxicology Section, Air Resources Branch, Ministry of the Environment. The criteria are based on phytoxicicity except for (3a), based on human health and (3b), based on animal health.

4) For coarse-textured (sandy) mineral soils the criteria for metals and metalloids should be reduced by one-half.

5) Criteria given is for fresh oil; for weathered oil, the criteria is 2 percent.

TABLE II

STEERING COMMITTEE - WORKSHOPS
DECOMMISSIONING CLEANUP AND RE-USE

MEMBERSHIP	SPONSORING AGENCY
ART STELZIG, MARIE LOUISE JEADAH	- ENVIRONMENT CANADA
ANDRE COUTURE	- ENVIRONMENT QUEBEC
BRIAN HAMMOND	- ENVIRONMENT ALBERTA
BARNEY SINGH	- ENVIRONMENT ONTARIO
MURRAY JONES	- PETROLEUM ASSOCIATION FOR CONSERVATION OF THE CANADIAN ENVIRONMENT (PACE)
JOHN KLASSEN	- CANADIAN CHEMICAL PRODUCERS' ASSOCIATION
BOB DRYDEN	- CANADIAN PETROLEUM ASSOCIATION (CPA)
	CONSULTANT
MARTYN RIDDLE	- MONENCO

The Steering Committee was enthusiastically supported by the sponsoring agencies and was assisted by Monenco as consultant. Table II lists the membership and sponsoring agencies of the Steering Committee.

The Steering Committee determined that priority should be given to the sharing of experiences by those who had been involved in decommissioning. Two workshops, Calgary (October 1985) and Ottawa (December 1985) were held with approximately 100 attendees each. It was by invitation and restricted to representatives from industry, consultants and government with experience in decommissioning. Citizen participants were invited to provide the citizens' perspectives, an often neglected element, due to the tendencies of engineers, scientists, industrialists, and government to focus on technical issues.

The format of the workshops was the presentation of papers on the first day. Appendix A lists the papers presented at the two workshops and the address from which copies of individual papers may be obtained. On the second day, small discussion groups deliberated on the following seven topics: Development of Cleanup Criteria (How Clean is Clean?) and Future Land Use; Design of Field Programs (Sampling, Health and Safety); Decommissioning of Smaller Industrial Facilities; Treatment and/or Disposal of Contaminated Material; Groundwater Cleanup Methods; Long Term Monitoring Liability Question (perpetual care); Role of Government and Public in Decommissioning.

A significant outcome of the workshops was recognition of the difficulty of determining "how clean is clean?" and the resolve to do something about this. The difficulty is related to determining what represents a safe level of contaminant that could be left in place without endangering the health and safety of citizens or the environment. A conference on How Clean is Clean?, held in May 1986 in Boston, illustrates the importance that is being attached to this subject. In cases where cleanup criteria exist, there is a need to determine how they were developed. Are they based on sound and rigorous scientific method, or were they based on best judgement to meet a pressing need?

Since cleanup criteria are likely to be at extremely low levels of concentration, the problem of laboratory analytical capability and availability was recognized. The laboratories of the control agencies (government) are severely taxed to meet existing demands and there

have been cases of serious discrepancies in analytical data from some commercial laboratories. In this field of rapidly changing technology, there seems to be a need for an accreditation system for laboratories and a mechanism for keeping such accreditation current. Quality control and quality assurance of laboratories need urgent attention to meet the growing analytical needs for decommissioning.

The sponsoring agencies, the federal government, the three provincial governments and the three industrial associations have agreed to continue support for the Steering Committee to work on two tasks in 1986. The establishment of an inventory of cleanup criteria and the development of methodology or methodologies for establishing criteria on sound scientific bases.

The first task is being undertaken by Environment Canada and embraces criteria from around the world, i.e. North America, Europe, Japan, etc. An important element of this inventory is the documentation of the rationale and methodology for each criteria. For the second task, the committee has sought funds from the sponsoring agencies which will be used to award a contract for the criteria methodology development study. The committee will co-ordinate these activities with the Waste Committee of the Canadian Council of Resource and Environment Ministers. Every attempt will be made to avoid duplication of effort and to seek acceptance of the work of the Steering Committee on a national basis.

A conference in 1987 to share developments in decommissioning with a wider audience is a longer term objective of the committee. It is felt that citizens, local municipal officials, the industrial community, the insurance industry and land developers can all benefit from well informed communication on what is required when faced with decommissioning, cleanup and re-use of industrial property.

Environment Quebec's Approach:

The Province of Quebec was faced with significant decommissioning and cleanup operations in recent years and urgently needed cleanup criteria and a sound approach. Environment Quebec consulted with and adopted the approach used by the Dutch who had previously dealt with urgent cleanup operations of significant magnitudes.

An internal discussion document, at the draft stage, was made available to the Steering Committee members. The intent is to develop cleanup criteria for contaminated

soils and groundwater. The document has not been officially adopted and reference should be made to Environment Quebec for the status of the Province's cleanup criteria.

The Dutch model on which the Quebec draft is based identifies three levels of action. Level A represents the background level (inorganic) or detection level (organic); Level B is a threshold value at which in-depth analysis are necessary to determine a course of action; Level C is a threshold values at which immediate corrective action may be necessary.

I wish to repeat that direct communication with Environment Quebec is necessary to obtain the status of the Quebec situation as an official position on cleanup levels has not been adopted to date.

New Jersey Approach:

In 1983, the State of New Jersey enacted the Environmental Cleanup Responsibility Act (ECRA). The following is a quotation from the guide to ECRA

> "under ECRA, the owner or operator of a firm, or the land on which it is situated, is required to notify the New Jersey Department of Environmental Protection (DEP) within five days of signing a sales contract, execution of an agreement of sale, a decision to exercise an option to purchase, or making public the decision to close the business. In the case of the transfer of property, the owner must, at least 60 days prior to the actual transfer of property, file with the DEP either a negative declaration or a cleanup plan. When closing operations, the owner must notify the DEP either at closing or 60 days following public release of the decision to close by applying for approval of a negative declaration or by submitting a cleanup plan for approval".

The intent of the legislation is quite clear. It imposes on all companies in SIC (Standard Industrial Classification) groups handling hazardous substances or wastes, the responsibility to ensure hazard free property at shutdown or transfer of ownership. If a negative declaration is made, it has to be accompanied by a sworn affidavit by an officer of the company and if

a cleanup plan is submitted, it must be accompanied by financial responsibilities to carry through with the plan. The penalties for false information to the DEP are $25.00 per day, voiding of any sale by the DEP, and voiding of the sale and the seeking of damages by the purchaser.

This very comprehensive legislation suffers from the shortcoming that has already been identified, the lack of cleanup standards. New Jersey has standards for only a limited number of substances and it has been necessary for the following clause to be part of the state legislation.

> "Until the adoption of the minimum standards required pursuant to Section 5A of the Act, the Department shall review, approve or disapprove negative declarations and cleanup plans on a case by case basis for soils, groundwater or surface water quality necessary for the detoxification of the site of an industrial establishment, including buildings and equipment, to ensure that the potential for harm to public health and safety is minimized to the maximum extent practicable, taking into consideration the location of the site and surrounding ambient conditions."

In addition, the DEP is willing to accept cleanup standards submitted by the decommissioning company, if a sound scientific basis can be established for such standards and the DEP can be convinced that such standards will create no hazards.

Ontario's Approach:

Having journeyed into Quebec and New Jersey, it is time to return to Ontario and to examine our approach.

There are few established standards. Table I, already referred to, shows current Ontario standards. The focus of Ontario's criteria is the re-use of property; the re-use categories are agriculture, residential/parkland, commercial/industrial. Our concern is based upon the

impact of the decommissioning operation, on effects to the future users of the property and on effects on the neighbouring residents and the environment. The Ministry has established a solid reputation with area municipalities and our position on the rezoning and re-use of property is actively sought and adhered to. In several cases, municipalities have made it clear that municipal approvals for re-use or rezoning of property will not be forthcoming without the Ministry's clearance. The Ministry's role is advisory.

At the moment, there is no legal clearance mechanism embodied in Provincial legislation. An approach being considered is that in which the decommissioner will provide a clean up plan for Ministry approval; the decommissioner will carry out the clean up in accordance with the approved plan and provide a declaration by a recognized professional of execution according to the plan or agreed upon changes; the Ministry will approve the cleanup plan and changes; the Ministry may inspect works during cleanup and will eventually issue a "clearance certificate" based on the cleanup plan and declaration of the decommissioner. A final mechanism for clearance is yet to be established.

The Ministry recognizes its role in decommissioning and approval for re-use of property and to date, has provided the service needed. There have been no delays due to the lack of a formal clearance mechanism. Decommissioning and cleanup activities have been undertaken in the spirit of co-operation as all parties recognize that unless an adequate and thorough job is undertaken, questions of long-term liability about future unknown hazards will remain; no one seems willing to allow these unknown hazards to exist.

Shell/Texaco Study:

Shell Canada Limited and Texaco Canada Incorporated are involved in the decommissioning of refinery properties at Oakville and Port Credit respectively. The Shell activity lead to the development of the Ministry guidelines. One of the many difficulties faced by these companies and the ministry was the lack of cleanup criteria for organic compounds.

Following consultation with EPA, a list of 43 organic compounds of significance, based on data for refinery operations in the USA, was identified. The two companies engaged a consultant to develop a methodology

to determine criteria for these compounds. Through groupings, the list was contracted to 10 substances which are considered to provide significant ranges of environmental and toxicological parameters so that a methodology to determine soil cleanup criteria developed for the 10 substances can later be applied to other substances if required. The work is closely co-ordinated with a working committee with staff from the Ministries of Environment and Labour.

The following is a quotation from the proposal which was submitted for this study.

> "Develop a pathways model to describe the routes by which contaminants move through the environment from the source (i.e. the contaminated soil), to the receptor (i.e. local residents living on decommissioned properties) and from a selected landfill within which the contaminated soil is disposed to a pre-determined receptor near the landfill".

A draft report has been circulated for comment. The work is being undertaken by Golder Associates in association with Senes Consultants Limited and CanTox.

Waste Management and Decommissioning:

From what has been said so far there can be no doubt that decommissioning of industrial sites is linked very closely with the management of waste. The amount of cleanup depends on how industry treated its wastes during its operating years.

If resources were used wisely; good operating practices observed; waste treated and disposed of off property; then decommissioning and cleanup of property for re-use would present few problems and could be undertaken at negligible costs. If good practices were not followed, then the cost could run into the millions and the dangers of long-term liability will forever lurk in the background.

The current mood of society is not to tolerate polluters. The attached notice entitled **Warning** tells its own story. The Ministry is actively considering revisions to the punitive sections of its legislation. It is time for industry to heed the mood of society and act wisely in controlling its wastes.

My experiences in decommissioning, cleanup and re-use of properties during the past three years have led to several conclusions. Each operator of an industrial facility should start thinking about decommissioning now. Conduct an environmental audit of the operation and eliminate bad practices. Stop all polluting activities now. If contamination is identified, start cleanup and prevent the further spread of such contamination.

I also recommend that decommissioning be a key element when planning new industrial plants. Be prepared for the certainty that what is built now will have to come down and the property will be required for re-use at some future time. It pays to ensure that the property will be a valuable and re-usable asset and not a liability of negative value. At the conceptual and planning stages, design for proper pollution management practices and build in the physical facilities to accommodate these practices.

Pollution and Decommissioning Costs:

A company faced with significant cleanup runs the risk of a severely damaged or completely destroyed reputation and of being branded as an enemy of society. Decommissioning and cleanup for re-use of property will cost a lot less if anti-pollution measures are taken now. Based on my experience with decommissioning, I recommend that every effort be made to avoid pollution during operating years. Without exception, the cost of cleaning up pollution far exceeds the cost of avoiding pollution.

WARNING

THE ILLEGAL DISPOSAL OF TOXIC WASTES WILL RESULT IN JAIL.

WE SHOULD KNOW WE GOT CAUGHT!

February 12, 1985

American Caster Corporation

Dear Businesses & Residents of the City & County of Los Angeles

Pollution of our environment has become a crisis.

Intentional clandestine acts of illegal disposal of hazardous waste, or "midnight dumping" are violent crimes against the community.

Over the past 2 years almost a dozen Chief Executive Officers of both large and small corporations have been sent to jail by the L.A. Toxic Waste Strike Force.

They have also been required to pay huge fines; pay for cleanups; speak in public about their misdeeds; and in some cases place ads publicizing their crime and punishment.

THE RISKS OF BEING CAUGHT ARE TOO HIGH—
AND THE CONSEQUENCES IF CAUGHT ARE NOT WORTH IT!

We are paying the price. *TODAY*, while you read this ad our President and Vice President are serving time in *JAIL* and we were forced to place this ad.

PLEASE TAKE THE LEGAL ALTERNATIVE AND PROTECT OUR ENVIRONMENT.

Very Truly Yours,

American Caster Corporation

141 WEST AVENUE 34
LOS ANGELES, CA 90031

CALGARY WORKSHOP

SYNOPSIS OF DAY 1 PRESENTATIONS

Copies of Papers can be obtained from:

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Telephone: (819) 997-3405

SYNOPSIS OF FORMAL PRESENTATIONS - CALGARY

1. OVERVIEW OF DECOMMISSIONING GUIDE

M.J. Riddle, Manager, Environmental Division, Monenco Consultants Limited, Calgary, Alberta and Carlson & Sweatt-Monenco Inc., New York.

This paper provides a brief overview of the contents of the "Guide to the Environmental Aspects of Decommissioning Industrial Sites". This Guide was prepared by Monenco under contract to the Environmental Protection Service of Environment Canada. The Guide was completed in April 1985 with input from the Canadian Petroleum Association (CPA), the Petroleum Association for the Conservation of the Canadian Environment (PACE) and the Canadian Chemical Producer's Association (CCPA) as well as various provincial agencies. Copies of the Guide can be obtained from the Publications Section of the Environmental Protection Service of Environment Canada (Report #IP-32).

2. POLICY AND REGULATORY REVIEW

a. "Advocate" - The Role of Environment Canada

P.J. Blackall, Director, Scientific Programs Branch, Environmental Protection Service (Western and Northern Region), Environment Canada, Edmonton, Alberta.

This paper provides a brief review of Environment Canada's role with respect to decommissioning.

b. Alberta's Current Procedures for Industrial Plant Site Decommissioning.

S. Lupul, Branch Head, Industrial Wastes Branch, Standards and Approvals Division, Alberta Environment, Edmonton, Alberta.

This paper provides a brief review of the procedures and policies in place within Alberta Environment for dealing with industrial plant site decommissioning.

c. Industrial Site Decommissioning - Saskatchewan's Position

B.J. Ryma, Industrial and Hazardous Waste Section, Land Protection Branch, Saskatchewan Environment, Regina, Saskatchewan

This paper provides a brief overview of Saskatchewan Environment's position relative to industrial site decommissioning.

d. Policy and Regulatory Review: Ontario Perspective

P.A. Fischer, Senior Environmental Planner, Land Use Coordination Section, Environmental Approvals and Project Engineering Branch, Ministry of the Environment, Toronto, Ontario.

This paper presents the Ontario Ministry of the Environment's (MOE) view of the most relevant policy and regulatory tools available to it when dealing with industrial site decommissioning, cleanup and reuse.

e. Policy Regulatory Review: Quebec Position

A. Couture, Direction des Substances Dangereuses, Environnement Quebec, Quebec City, Quebec.

This paper briefly reviews Environnement Quebec's position relative to industrial site decommissioning cleanup and reuse.

3. HISTORY OF PUBLIC INVOLVEMENT WITH THE NATURAL GAS INDUSTRY IN PINCHER CREEK AREA

S. Taylor, Pincher Creek, Alberta.

This paper briefly reviews the history of public involvement with the natural gas industry in the Pincher Creek area of Alberta from public participants' and local citizens' standpoint.

4. PUBLIC PARTICIPATION IN THE DECOMMISSIONING OF INDUSTRIAL SITES

V. Millard, Chairman, Energy Resources Conservation Board, Calgary, Alberta.

This paper reviews the role of public participation in the approval and operating phases of energy projects in Alberta. It also examines recent changes in public participation and concludes with details of 13 steps the author believes are a necessary and realistic part of the public's input to a decommissioning program.

5. DECOMMISSIONING EXPERIENCE IN THE UNITED STATES

a. Environmental Cleanup Responsibility Act (ECRA) of New Jersey

A.J. McMahon, Chief, Bureau of Industrial Site Evaluation, Division of Waste Management, New Jersey Department of Environmental Protection, Trenton, New Jersey.

This paper provides an overview of ECRA - a New Jersey law aimed at determining the environmental acceptability of properties, establishing the responsibility for remedial actions at contaminated sites and assuring potential buyers that they are purchasing property free from significant contamination. ECRA is currently the most powerful legislative tool in the USA relating to industrial site decommissioning, cleanup and reuse.

b. New Jersey's ECRA Program - Private Sector Viewpoint

I.L. Whitman, President, The Whitman Companies, East Brunswick, New Jersey.

This paper highlights the viewpoint and concerns of the private sector, i.e. the regulated parties, with respect to ECRA. It reviews the political environment when the law was passed, broad industry viewpoint of ECRA, applicability, compliance with technical requirements as well as procedural problems with ECRA.

6. DETAILS OF DECOMMISSIONING GAS PLANTS

J.G. Hawkins, Environmental Division, Monenco Consultants Limited, Calgary, Alberta.

This paper reviews in detail a step-wise approach to decommissioning industrial sites. Activities summarized include plant site assessment, reconnaissance testing program, development of cleanup criteria, detailed field testing program, preparation of cleanup plans, implementation of site cleanup, confirmatory testing and finally long-term monitoring.

7. REVIEW OF PINCHER CREEK GAS PLANT DECOMMISSIONING

L.T.L. Callow, Coordinator-Environmental Protection and Reclamation, Gulf Canada Resources, Calgary, Alberta, and

T. Kewen, Environmental Division, Monenco Consultants Limited, Calgary, Alberta.

This paper provides a summary of the activities surrounding the decommissioning of Gulf's Pincher Creek Gas Plant, the first major sour gas plant to be decommissioned in Alberta. Decommissioning activities began in 1982 and will not be complete until 1986 or 1987. The paper outlines

general features of the plant and plant site, provides an overview of the decommissioning studies at the plant site, summarizes cleanup and reclamation measures at the plant site, and details general conclusions from the program completed to date.

8. DECOMMISSIONING OF PETROLEUM REFINERIES

H.J. Carter and C.E. Hailes, Texaco Canada Inc., Toronto, Ontario.

The paper outlines the planning steps taken by Texaco Canada Inc. to decommission and environmentally cleanup its three shutdown refineries. The paper briefly describes: the locations, ages, sizes and unique features of the plants; the key steps taken in developing and implementing the cleanup plans, including the preliminary stages; the field investigation stage; and the cleanup and post cleanup stages. The paper also deals with the decommissioning and cleanup of the Port Credit Plant North Tank Farm as a case study. The project is the most advanced of Texaco Canada's decommissioning projects to date. In concluding, the paper gives a very brief overview of decommissioning activities at the other shutdown plants, including some of the key differences that the project teams face.

OTTAWA WORKSHOP

SYNOPSIS OF DAY 1 PRESENTATIONS

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2. POLICY AND REGULATORY REVIEW

a. Decommissioning - The Role of Environment Canada

V. Shantora, Director, Industrial Program Branch, Environmental Protection Services, Environment Canada, Ottawa, Ontario.

This paper provides a brief review of Environment Canada's role with respect to decommissioning.

b. Policy and Regulatory Review: Ontario Perspective

P.A. Fischer, Senior Environmental Planner, Land Use Coordination Section, Environmental Approvals and Project Engineering Branch, Ministry of the Environment, Toronto, Ontario.

This paper presents the Ontario Ministry of the Environment's (MOE) view of the most relevant policy and regulatory tools available to it when dealing with industrial site decommissioning, cleanup and reuse.

c. Policy and Regulatory Review: Quebec Position

A. Couture, Direction des Substances Dangereuses, Environnement Quebec, Quebec City, Quebec.

This paper briefly reviews Environnement Quebec's position relative to industrial site decommissioning cleanup and reuse.

d. Alberta's Current Procedures for Industrial Plant Site Decommissioning

S. Lupul, Branch Head, Industrial Wastes Branch, Standards and Approvals Division, Alberta Environment, Edmonton, Alberta.

This paper provides a brief review of the procedures and policies in place within Alberta Environment for dealing with industrial plant site decommissioning.

3. INDUSTRIAL SITE DECOMMISSIONING: THE NEED FOR PUBLIC INVOLVEMENT

a. B. Walker, Research Director, STOP Inc., 1361 Greene Avenue, Montreal, Quebec.

This paper briefly outlines the need for public participation in decommissioning based on the experience at La Salle Coke in Montreal.

b. D. Green, Co-President, Societe pour Vaincre La Pollution (SVP), CP 65, Place d'Armes, Montreal, Quebec.

This paper provides a brief review of the lessons learned from the La Salle Coke decontamination project in Montreal. The paper outlines the role of the government and the public during this project.

4. PUBLIC PARTICIPATION

V. Jendruszka, Watchdog Committee Against Pollution, Toronto, Ontario.

This paper reviews the problems surrounding public participation in the Junction Triangle area of Toronto and specifically during the cleanup of PCB's at the Canadian General Electric site.

5. DECOMMISSIONING EXPERIENCE IN THE UNITED STATES

Environmental Cleanup Responsibility Act (ECRA) of New Jersey.

A.J. McMahon, Chief, Bureau of Industrial Site Evaluation, Division of Waste Management, New Jersey Department of Environmental Protection, Trenton, New Jersey.

This paper provides an overview of ECRA - a New Jersey law aimed at determining the environmental acceptability of properties, establishing the responsibility for remedial actions at contaminated sites and assuring potential buyers that they are purchasing property free from significant contamination. ECRA is currently the most powerful legislative tool in the USA relating to industrial site decommissioning, cleanup and reuse.

6. EXPERIENCE ON SOIL CONTAMINATION IN THE NETHERLANDS

G.C. Molenkamp and I.M.J. Bins - Hoefnagels, Volder and Co., Environmental Consultancy (Touche Ross, Rijswijk, The Netherlands).

This paper provides a comprehensive review of the experiences with identifying and solving soil contamination problems in the Netherlands. The paper reviews the following areas:

- o contamination found on former industrial sites,
- o four case studies,
- o review of methods of investigation,
- o development of cleanup criteria,
- o currently utilized cleanup techniques

The paper concludes with a review of the current state of affairs relative to soil contamination in the Netherlands.

7. EXPERIENCE IN DECOMMISSIONING AND CLEANUP OF INDUSTRIAL FACILITIES IN QUEBEC

J. Barter and M. Poulin, Environmental Division Manager and Senior Hydrogeologist (respectively), Societe d' Ingenierie, Cartier Limitee, Montreal, Quebec.

This paper reviews in detail the main elements of a step-wise approach to decommissioning industrial sites. Topics discussed include:

- o cleanup criteria and future land use,
- o plant site assessment,
- o reconnaissance testing program,
- o detailed testing program,
- o development of cleanup plans,
- o site cleanup and confirmatory testing, and
- o long-term monitoring

8. CHEMICAL PLANT DECOMMISSIONING

J.A. Myers, Du Pont Canada Inc., Maitland, Ontario

This paper reviews the activities associated with the decommissioning and cleanup of the tetraethyl lead (TEL) manufacturing facility, which is part of Du Pont Canada's Maitland, Ontario, complex. The shutdown, decommissioning and site cleanup, which is estimated to cost $10.5 million, began in June, 1985. It is expected that this project will take about 1-1/2 years. This paper reviews objectives of the decommissioning program, under the headings safety and health control, environmental and operations. Plant decontamination procedures are discussed as are site sampling requirements.

9. SHUTDOWN AND DECOMMISSIONING OF SHELL CANADA'S OAKVILLE REFINERY - ENVIRONMENMENTAL ASPECTS

K.J. O'Hearn, M.G. Jones and D.M. Hagopian, Shell Canada Ltd, Calgary, Alberta.

In July, 1983, Shell Canada closed its Oakville, Ontario, refinery and announced that the refinery would be dismantled and the site developed for alternate use. This paper discusses the environmental steps taken in the shutdown of the refinery, including the site assessment, disposition of wastes and the interaction with the regulatory authorities. The paper reviews in detail the environmental issues identified for the Oakville site - the issues included:

- refinery soil quality,
- groundwater quality,
- lead,
- catalyst and chemical disposal,
- hydrocarbon disposal,
- treatment of wastewater,
- asbestos, and
- cooling water tower disposal

The method of handling each issue is discussed.

REFERENCES

1. Guide to the Environmental Aspects of Decommissioning Industrial Sites, May 1985 by Monenco Consultants Ltd. for Supply and Services Canada DSS8040-4/2472

2. Guidelines for the Decommissioning (Shutdown) of Major Industrial Sites in Ontario, June 1984. Ontario Ministiry of the Environment.

3. A Guide to the Environmental Cleanup Responsibility Act New Jersey Department of Environmental Protection CN-028.

4. *Technical Proposal - Development of Criteria for Trace Organics, Texaco's Port Credit Refinery, Shell's Oakville Refinery - by Golder Associates in association with Senes Ltd., CanTox Inc.

*This is not a published public document.

INCINERATION OF PCBs BY PLASMA ARC*

by M.F. Joseph President, Westinghouse Plasma Systems Canada Inc, Niagara Falls, Ontario; T.G. Barton, Vice-President, Pyrolysis Systems Inc., Kingston, Ontario; and S.C. Vorndran, President, Westinghouse Plasma Systems U.S. Inc., Madison, PA

ABSTRACT

A high temperature plasma has been shown to efficiently destroy a variety of organic liquids including high concentration transformer Askarel fluids. The mobile Pyroplasma^{T} unit has been tested rigorously over a three year period on a range of chlorinated and non-chlorinated liquids and has achieved destruction efficiencies in excess of 99.99999%. The system is presently being marketed worldwide by Westinghouse Plasma Systems Inc.

INTRODUCTION

The Pyroplasma^{T} technology has been under development in Canada for the past 10-12 years at the Royal Military College in Kingston, Ontario. In 1982, the New York State Department of Environmental Conservation and the U.S. Environmental Protection Agency entered into a contract with the owner of the technology, Pyrolysis Systems Inc. Design and construction of the prototype unit for use at Love Canal in NYS was completed including a rigorous testing program to prove the capabilities of the waste destruction process. Permitting for operation at Love Canal based on these test results is now underway.

In early 1986 Westinghouse Electric Corporation in the United States formed a joint venture partnership with Pyrolysis Systems Inc. of Canada. Two new companies were formed, both responsible for the development and marketing of the Pyroplasma^{T} technology, Westinghouse Plasma Systems of Canada and the U.S.

Testing was carried out on a series of chlorinated (PCBs and CCl_4) and non-chlorinated (methanol, ethanol, methyl ethyl ketone) liquids to test the systems mechanical operation and destruction efficiencies. These tests were of both short and long duration in order to establish the commercial viability of the units for the marketplace.

*Pyroplasma^{T} PCB Destruction

PROCESS DESCRIPTION

The Pyroplasma^{T} unit is entirely contained in a 48 foot tractor trailer and requires only power, water and sanitary sewer discharge lines. The power requirements are 4160 volts, 3-phase. Domestic water supply and access to a sewage treatment plant (STP) are the only additional external requirements other than a waste source. Only a matter of a few days are required for complete system mobilization to the point of actual operation. There are presently two commercial size units available: a 1 gallon per minute (GPM) unit operating at 350 kW and a 3 GPM unit operational at 650 kW. Mobile units may be designed with throughput capacities as high as 6 GPM and still be contained in a single trailer. While present emphasis has been on the design of mobile units for reasons of lower environmental risk and greater public acceptance, the construction of fixed facilities is possible in the event that higher throughput capacities are required.

The Pyroplasma^{T} process is based on the concept of pyrolyzing waste molecules using a thermal plasma field. The heart of the destruction system is a plasma torch which was designed by Westinghouse Electric Corporation and Pyrolysis Systems Inc. Similar torches have been used commercially for years in practical applications ranging from blast furnaces and boiler ignition to the testing of atmospheric reentry heat shields by NASA.

The 3 GPM unit uses 650 kW of electric power across a colinear electrode assembly producing an electric arc which causes an injected low pressure air stream to be ionized forming a thermal plasma with temperatures in the 5-15,000 degree Celcius range. Waste molecules introduced to this plasma are completely dissociated into their atomic components and these recombine to form non-toxic gases, typically carbon monoxide, nitrogen, and hydrogen along with some lower molecular weight hydrocarbons (i.e. methane, ethane, etc.). Acid gas formed from the destruction of chlorinated wastes and the recombination of hydrogen and chlorine gases is neutralized in a wet scrubber with caustic soda (sodium hydroxide) to form a slightly salted (sodium chloride) water effluent. Any particulate carbon produced is also removed in this stream. The product gas (usually about 40% hydrogen, 25% carbon monoxide, 15% nitrogen and 10% water) is drawn off by an induction fan and flared directly. The fuel value of the product gas is 2-3 times the actual power required for the torch due to the energy released from the breaking of waste molecular bonds and the high torch efficiencies of about 80%.

Actual system operation and behavior are controlled based on operator experience and predicted models. The feed stream can be analyzed and the molecular components of the waste computer modeled according to chemical kinetics to give predicted theoretical product gas values closely approximating those of the product gas actually produced by the unit. Careful blending of the waste prior to destruction can shift gas constituents and their relative amounts to within +/- 1% of desired ranges. The unit is started by electrically powering the torch which activates the plasma instantaneously. Operation begins with the use of a non-toxic type solvent contained on board the trailer (i.e. methanol) and is continued for approximately 15 minutes until such time as the reactor stabilizes at an appropriate temperature, typically around 1000 C.

Reactor temperature is established only to control the types of recombination gases being produced. System destruction efficiencies are not reactor temperature value dependent because the waste destruction process is pyrolytic in nature occurring in the plasma field not a combustion process occurring in the reactor. It is the adequate quenching of the torch power realized as an in-out energy balance that ensures efficient destruction of the incoming waste. This energy balance is monitored by the operator (and computer) and controlled and maintained by adjusting either torch power, waste feed flow or torch process gas flow thus ensuring a stable or non-fluctuating reactor temperature.

The entire system is process computer controlled through a series of temperature, pressure, electrical and flow sensors. While the operation of the unit is monitored and directed by a technically experienced person the computer has overriding control. This is based on a series of control parameters set according to operational limits inside which system efficiency may be ensured and risk to the environment eliminated. There are numerous failsafes built into the system even in anticipation of complete power failure, a worst case situation. In addition there are several gas monitors ensuring that the system is operating according to theoretical models and therefore in an efficient manner.

TEST RESULTS

There have been a wide variety of successful test runs performed on the prototype 1 GPM Pyroplasma[1] unit. The test program as conducted under the PSI contract with NYS consisted of three phases: a mechanical shakedown of the unit, carbon tetrachloride runs, and PCB tests. All phases were observed by both federal and state authorities from the U.S. and federal, provincial and local authorities from Canada. Sampling and analyses of both gaseous and liquid effluent streams were conducted by external agencies under the auspices of Canadian and American authorities and in accordance with accepted protocols.

Mechanical operation was tested by processing through the unit approximately 20-30,000 liters of a non-toxic, non-chlorinated feed blend of methyl ethyl ketone and methanol. Operating parameters for the 1 GPM unit were 350 kW of electric torch power with operating temperatures of 1000 C for the reactor, 60 C for the scrubbed product gas and 50 C for the scrubber water. Typical water effluent flow rates were about 25 liters per minute. This phase proved the long term operational and mechanical stability of the system.

The next phase was a series of carbon tetrachloride tests designed for three specific reasons: to examine unit operation under heavy chlorine loading and its possible effect on mechanical operation; to determine the destruction efficiency of the torch on a highly refractory chlorinated compound; and to measure the efficiency of the scrubber for the removal of HCl. Three one-hour tests were performed on CCl_4 blended with methyl ethyl ketone at a CCl_4 feed concentration of approximately 35% by mass and a feed rate of about 1 kg per minute. Destruction efficiencies for all three tests were greater than 99.9999% measuring emissions from both stack and scrubber effluents. Better than 99% of the HCl produced in the system was removed by the scrubber.

The last phase was a series of concentrated PCB tests performed on Askarel transformer fluids. Three one-hour tests and four longer duration tests were performed. The results from these tests showed destruction efficiencies consistently higher than 99.99999%. Destruction removal efficiencies based on stack emissions alone were typically an order of magnitude higher still. The chlorinated feed test results are tabulated below in Table 1.

In addition to the high destruction efficiencies obtained during the chlorinated test runs, the products of incomplete combustion (PICs) of the most concern environmentally (specifically dioxins and furans) were generally non-detectable in both the stack gas and water effluent. When these compounds were detected it was typically at the part per trillion level. HCl, NO_x, and particulate levels in the stack were also well below maximum accepted limits.

Table 1. Chlorinated Feed Test Results

Test #[1]	Date	POHC[2]	Run time (minutes)	DRE[3] (%)
1	2/18/85	CCl_4[4]	60	99.99998
2	2/26/85	CCl_4	60	99.99998
3	2/26/85	CCl_4	60	99.99998
3	12/05/85	PCB[5]	50	99.999997
4	12/17/85	PCB	60	99.999994
5	1/16/86	PCB	60	99.99996
6	2/12/86	PCB	150	99.999998
7	2/20/86	PCB	300	99.9999998
8	2/22/86	PCB	300	99.9999998
9	3/12/86	PCB	300	99.999999

1. Tests 1 and 2 in the PCB series were solvent runs
2. POHC (Principal Organic Hazardous Constituent)
3. DRE (Destruction Removal Efficiency based on stack emissions)
4. CCl_4 (carbon tetrachloride feed, 35-40% by mass)
5. PCB (Askarel transformer fluid, 12-18% by mass pure PCBs- Aroclors 1254 & 1260, approximately the same mass % trichlorobenzene)

CONCLUSIONS

These tests proved the ability of the mobile Pyroplasma^{T} system to efficiently destroy a variety of toxic chlorinated wastes. The total list of chemicals successfully processed by the unit includes methanol, ethanol, methyl ethyl ketone, water, carbon tetrachloride, and Askarel (including pure PCBs and chlorobenzenes along with low levels of dioxins and furans).

THE SUCCESSFUL APPROVAL OF AN ENERGY FROM WASTE INCINERATOR

Three-part presentation by W.P. Torbet, 3M Canada Inc., J W Kennedy, Enercan Inc., and Dawn Erskine, City of London

PART I

Presented by W. P. Torbet

3M Canada Inc.

3M Canada has proposed to construct an Energy from Waste plant on its Oxford Street site in London, Ontario. The facility will incinerate 60 T.P.D. of dry solid industrial scrap and the combustible components of a process exhaust, used as combustion air, to generate 30,000 lbs./hr. of steam to be used for process and building heating. The 15,000 sq. ft. facility will be constructed adjacent to our present power house now generating the site steam requirements. The incinerator will use the two stage combustion process with a rotary kiln as the primary combustion chamber. A majority of the solid waste will be taken from offsite, hence a public hearing was required under the Environmental Protection Act Part V to operate a waste disposal site. The hearing was held in October 1985 and subsequent to this 5½ day hearing a Provisional Certificate of Approval was issued in February 1986.

At the outset of this program we made the observation that it had to be described in terms that are meaningful and understandable to everyone, our management, our employees and the general public.

So, we first identified the benefits to society: That the use of commercial and non-hazardous solid industrial waste as fuel is clearly one of the most promising methods of achieving three major goals:

1) conserving energy
2) improving the environment
3) helping Canada's export sales potential through making industry more competitive

We then expanded on these thoughts by identifying the five benefits to the community and the company. An energy from waste plant would:

1) Provide 90% of 3M's process and heating steam needs
2) Reduce the number of loads of waste going to the municipal landfill site - thereby extending its life by one to two years
3) Eliminate an odour that is sometimes an annoyance to local residents and employees alike.
4) Safely and effectively dispose of scrap from 3M and other sources.
5) And also, it responds to government initiatives and guidelines to improve waste handling and disposal methods now and in the future.

Now, let's review the reasons we feel led to a successful application and hearing.

From our viewpoint there are several:

1) The reputation of 3M Canada as a responsible and caring company. It has a long record of community responsibility and respect for the environment, its neighbours and employees.

2) Enercan's experience in both the design and operation of similar units. This expertise and practical experience enabled all who took part in the application process to better understand the benefits as well as the operation of the proposed project.

3) The test results from the National Incineration Testing and Evaluation Program in P.E.I. The information which came from these tests were highly instrumental in showing that the 3M project would be far better than required by the M.O.E.

4) Experienced legal counsel and other experts. 3M's legal counsel who had direct experience with other such applications and the other experts who testified at the hearing or provided data were responsible in their approach.

5) Communications. Clear understandable communications to all. From 3M management to employees, to our neighbours and to the general public.

6) The responsible and positive approach of the citizens' committee, the Pottersburg Creek Pollution Committee. This group acted as the voice of the local residents and can be commended for their mature and sensible actions.

7) The approach of the Hearings Board.

I'd like to concentrate on the last three items -- Communications, the citizens' committee and the Hearings Board.

The first subject, communications, is extremely important. If the communications side of the project is overlooked, then no matter how good the system itself may be from a technical standpoint, the fear and misunderstanding which may occur can seriously extend the hearings or even scuttle the project due to public outcry.

From day one we insisted on being totally open in all our communications with all our potential audiences.

The first group we had to convince was our management. They wanted to know, in laymen's terms what the system would do but above all whether it was safe, reliable and of no danger to our employees, neighbours or the surrounding community.

Once we had their approval we then had the task of introducing it to all the various publics...and in a way that would convince everyone that we had not only done our homework...but that the project was indeed important, useful, safe and environmentally sound. And in doing so we continued to use laymen's terms and keeping away from technical jargon.

Prior to going public with the information that we were about to undertake an Energy From Waste project we took several individuals into our confidence. We contacted area MPs, MPPs, some members of city council, including the Mayor and the CEO or equivalent of neighbouring companies. The purpose of this round of communication was so that neither the politicians nor other businesspeople in the area would be surprised or caught off guard by questions from their constituents, the public or employees.

Next, we had to inform our employees and get them onside, so to speak, but we also had to tell the area residents, the Union at the plant and the general public through the media.

In order that no one be left out nor receive the information at the wrong time, several of these communications were done simultaneously and in all cases each group was given the same information.

As a news conference was going on an announcement was posted at 3M inviting employees to a presentation later in the day so they could receive the same information as the news media.

Also at the same time, area residents were getting a hand delivery of an information package about the project and an invitation to attend a public meeting a week later.

As spokesperson for the news conference we chose an executive who had some knowledge of the process instead of a P.R. person or a technical expert. We had these people on hand but the executive lent credibility and weight to the presentation.

For the public meeting we chose a community college which was very near 3M. This kept the location well within easy reach of the area neighbours located on a neutral site and offered good auditorium facilities.

We were also fortunate in obtaining the cooperation of the Dean of the College to act as Chairman of the proceedings so as to make the meeting as objective as possible.

Whenever we spoke about the project, the same positive benefits were outlined and an invitation was extended to anyone to phone in to an "information hotline" that we had set up.

Following these first announcements and the public meeting we continued to provide information to all these people every time any significant change took place or when we wanted to clarify an issue. For instance, when a negative letter to the editor appeared we posted it for our employees to see but added our own rebuttal and then sent copies of this to the list of local politicians and neighbouring firms. Of course we contacted the person who had written the letter, cleared up the misunderstanding and he subsequently became a supporter of the project and wrote another letter to the editor to this effect.

The second subject is the role played by the citizens' committee.

A hearing date was established in August, however we requested an adjournment to provide time for the test results from the Charlottetown P.E.I. system under the N.I.T.E.P. program to become available. The citizens group at the same time requested an adjournment to provide time to gather information and funding for legal and technical assistance. The hearing was adjourned for six weeks and the board agreed to retain an expert, selected by the citizens group and agreed to by 3M. Separately the citizens group obtained funding for legal counsel.

During the adjournment we met with citizens' committee twice. Once to present the N.I.T.E.P. results and another to review the system operation and advise them of the decision to change from a wet scrubber to a dry lime injection/baghouse system.

The positive approach taken by the citizens committee was reflected in their willingness to understand the E.F.W. system.

This citizen's committee was originally set up to obtain action on PCB pollution coming from another industry near 3M so their interest was high in our project.

From the outset, however, at the public information meeting we held the week after the news conference, the group stated they were not opposed to the project but that there were concerns that they wanted to be sure would be addressed during the public hearing.

That was their opening statement at the Board Hearings and we felt that their actions consistently showed that this was indeed their key purpose.

The third subject that should be highlighted is the role of the Hearings Board.

By charging the parties, 3M, the M.O.E. and the Citizens' group to get together and communicate during the postponement they enabled the writing of conditions into the application to which all parties were in agreement.

The Board appointed an expert at its own expense who could offer his opinion to the citizen's committee and was also able to review conditions filed by 3M. Negotiations and discussion as suggested by the Board, resulted in agreement by all on conditions to be attached to the Certificate of Approval and thereby resulted in a relatively short (5½ day) hearing.

Certainly there were many factors affecting the aproval process. In retrospect, the three we have emphasized are some of the key ones.

In our opinion a well developed project with strong rationale and effective communication are all essential for acceptance and approval.

PART 2

Presented by J.W. Kennedy
Enercan Inc.

Enercan is a manufacturing and service contracting company which is supplying an Enerkiln energy from waste system to 3M on a turn-key full-service basis. Key personnel within Enercan have been involved in seven energy from waste facilities and this related experience provided a vital component to the successful approval process.

To prove to the Hearing Board and the citizen's group that the proposed Enerkiln system can be relied upon to perform in an environmentally acceptable manner, Enercan stressed to them that the proposed system employed the same two-stage combustion process as an existing successful operation.

The Enerkiln system is a combination of two well-proven technologies; two-stage combustion and rotary kiln combustion. The NITEP program carried out at the PEI energy from waste facility by Environment Canada, proved conclusively that two-stage combustion is very efficient in the destruction of trace organics including dioxins. Key personnel, who are now at Enercan, were instrumental in the design, construction and initial operation of the PEI energy from waste plant. This successful experience was incorporated into the Enerkiln system.

Enercan is also operating a 120 TPD two-stage combustion energy from waste plant in Cuba, New York. A 25 TPD prototype Enerkiln process was installed by Enercan at the Ontario Centre For Resource Recovery and operated for a period of five months, with full continuous monitoring of the process. The operating experience gained from the Cuba plant and the prototype Enerkiln system together with the NITEP program results provide a comprehensive data base for the proposed Enerkiln system at 3M.

Ontario Research Foundation reviewed existing published data on emissions from two-stage combustion facilities. From these data and performance criteria for the gas cleaning system, the proposed 3M facility was assessed to have no significant impact on the ambient air quality. The NITEP data confirmed the validity of the ORF data and of the conclusions drawn from the data.

To build on the relationship between the PEI plant and the proposed 3M facility, Enercan described the differences between the two plants that should result in even better performance.

FEATURES	PEI ENERGY FROM WASTE PLANT	PROPOSED FACILITY FOR 3M
Waste Composition	Municipal solid waste averaging 4500 Btu/lb.	Commercial & industrial scrap averaging 6900 Btu/lb.
Pre-processing of Waste	Waste is handled as-received on the floor where some mixing occurs and oversize material is rejected.	Coarse size reduction and increased mixing reduce variations for more effective combustion.
Feed System	A batch-type ram feeder periodically injects a charge of waste into the primary furnace chamber.	A continuous ram chute feeder provides a steady fuel feed to the Enerkiln furnace achieving more uniform combustion and heat release.
Primary Chamber	Mechanical rams move the waste over a stepped hearth. Air is injected into the waste bed through water cooled tubes. Infiltration of tramp air can occur during feeding and around the rams.	A rotary kiln with no internal moving parts gently tumbles the waste against the hot kiln lining. Combustion air is closely controlled and air leakage is minimized.
Secondary Chamber	Low pressure air mixes with combustion gases throughout the chamber.	High pressure air jets ensure rapid mixing with combustion gases which are retained above 1000°C for more than one second.
Air Pollution Control	None	A lime injection/ baghouse gas cleaning system.

PROCESS DESCRIPTION

A summary description of the proposed Enerkiln system for 3M follows:

Solid waste fuel will be discharged from waste collection vehicles onto the flat floor of the enclosed receiving and storage building.

Due to the expected wide fluctuations in the size of the solid waste material, a heavy-duty slow-speed rotary shear-type shredder is provided to reduce bulky solids to a uniform size. A front-end loader is used to feed bulky materials to the shredder, pile "as-received" and shredded waste in the storage areas and to transfer waste periodically to the hopper supplying the incinerator feed conveyor. During each of these steps, the operator of the loader has the opportunity to examine closely the waste composition, removing unsuitable items for disposal according to M.O.E. directions. The use of a tipping floor permits recycling of recoverable materials when economic factors justify it.

Solid waste fuel is fed to the primary combustion chamber of the Enerkiln system at a controlled rate by a hydraulic ram. The hopper above the feed ram receives the waste fuel as required by means of a fuel feed conveyor. The conveyor also provides more than one hour capacity of solid waste fuel storage.

The Enerkiln system is designed so that the initial combustion stages take place under substoichiometric (below proper chemical proportions) conditions in a rotary kiln. The partially combusted gases released from the solid waste fuel pass into a secondary chamber where the combustion process is completed. The solid waste fuel is rotated slowly in the kiln and this circular movement combined with the slope of the kiln produces an effective gentle tumbling action thereby transporting the burning

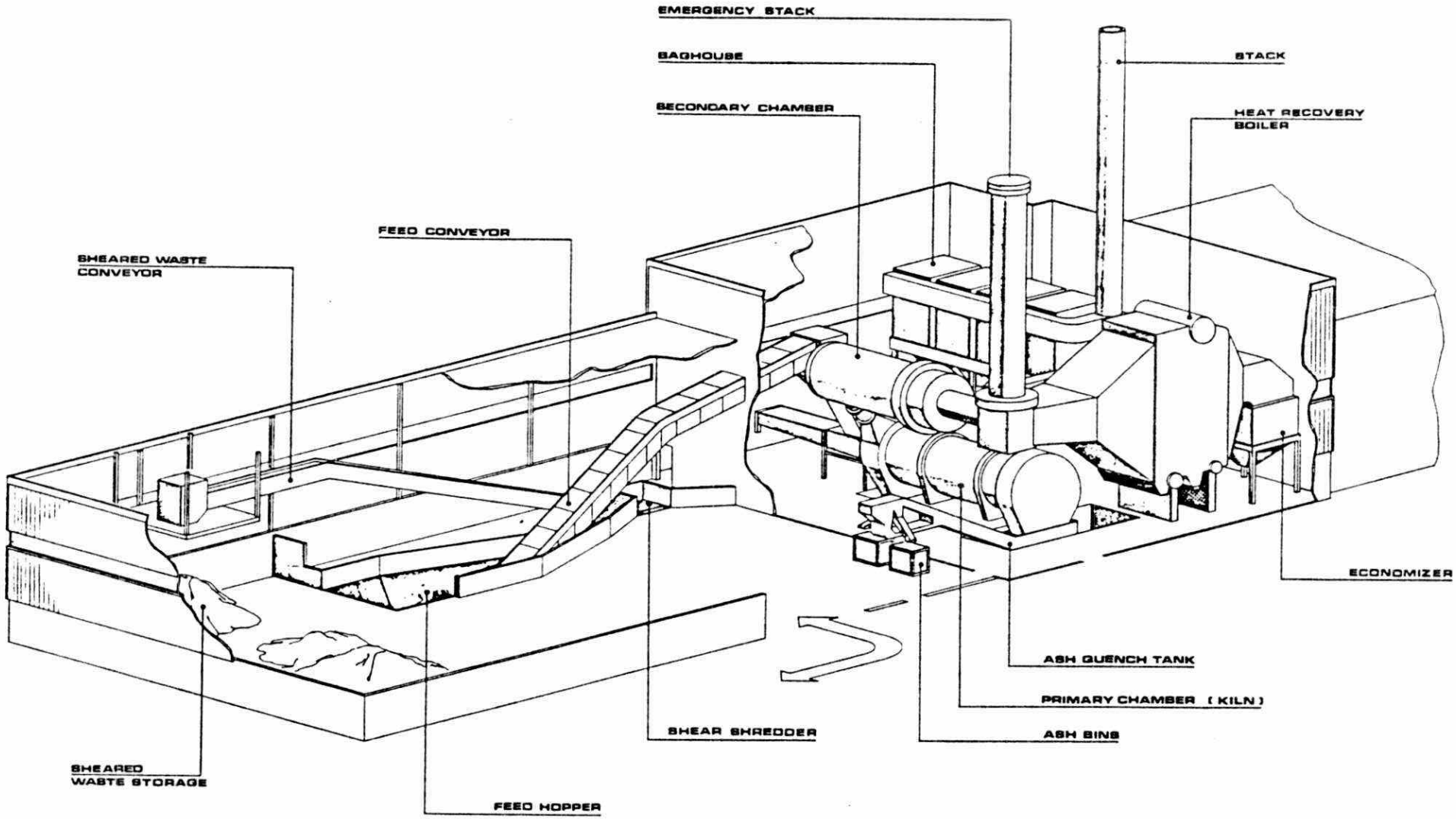
waste toward the discharge end. As fresh waste enters the kiln it is dried by the hot gases and then passes into the next zone where the volatile organic components are driven off. The carbon remaining in the hot residue is oxidized by a controlled amount of combustion air injected at the ash discharge end of the kiln. The resulting hot flue gas, depleted of oxygen flows at low velocity, through the volatilizing and drying zones of the kiln before moving into the secondary combustion chamber.

As partially combusted gases coming from the primary chamber enter the secondary chamber, and come into contact with a controlled amount of excess air injected through tangential ports, vigorous mixing occurs. The additional air is a combination of oven exhaust from the 3M plant and ambient air. Thorough oxidation of the volatile organic component of the oven exhaust and of the primary chamber gases is ensured by the effective mixing process and by baffles which prevent short circuiting of the gas flow. A retention time of at least one second at a temperature above 1000°C (1832°F) must be achieved. An auxiliary burner is provided for initial warm-up and for supplementary heat if required to maintain this temperature. Thermocouples are located at the discharge end to ensure gas temperatures do not fall below 1000°C (1832°F).

The combusted gases from the secondary chamber are ducted to a heat recovery boiler equipped with an economizer.

Between the economizer and the baghouse, the combusted gases flow through a duct where dry lime is injected. The dry lime injection system is to provide an alkaline material which will neutralize the acidic content of the gas stream. Secondly, the dry lime provides a pre-coating of the filter material in the baghouse so that particulate removal is more effective.

The filtered gas is vented to the atmosphere by the I.D. fan through a stack.



3M EFW PLANT

LONDON, ONTARIO

PART 3

Presented by Dawn Erskine
Pottersburg Creek Pollution Committee

I first became involved in environmental issues in July 1984, when I learned of P.C.B. contamination in the creek that runs through my backyard. It's called Pottersburg Creek, perhaps some of you are aware of it. My husband grew up in the home where we live, and we have a son who is now six, who is naturally curious.

I don't believe that pollution is acceptable anywhere, but especially not where children, live, grow and play. We formed a citizens group in order to have a stronger voice in insisting that the pollution be cleaned up and that the health impact be addressed.

One year later almost to the day, in July 1985 we were well on the road to achieving all of our goals. We thought we could soon sit back and savour our sweet success. I was also in the preparation stage of my first campaign to run for Alderman in London. 3M Canada had other plans for me as they announced that they were working on a project to build an Energy From Waste Plant. 3M is located not too far from the residential area where I live.

The Pottersburg Creek Pollution Committee members first reaction was "here we go again" and our defence and mistrust walls immediately went up. 3M to us it seemed that 3M was really pushing their luck and we felt that they could have at least waited until the dust had settled from our creek issue. It was summer and a lot of our committee members were on holidays, as well as were other people whom I knew had worked on the Victoria Hospital E.F.W. hearings. We assumed that 3M somehow was also aware of this time factor and therefore planned their announcement to coincide. "This of course would be virtually impossible."

3M distributed notices of a meeting that was to be held explaining what their project was all about. They somehow missed my street. I immediately called 3M to make them aware that we had not received a notice and that I was more than interested in what they were going to do. They were very apologetic and asked what area I would like to have receive notices and that they would ensure their delivery. That same afternoon I received a complete information package delivered to my door, detailing their project. I also received an invitation to call at any time with any questions and they would be glad to help.

I have since learned that Victoria Hospital had the same complaints with area residents not receiving notices in a wide enough area, even though they had calculated a mile radius around their site to be sufficient. I believe this shows that you can never cover too big an area, when making people aware of your plans.

Within one week of the announcement, 3M held a public meeting at Fanshawe college, which is located almost next door to 3M. This location being within our community made it accessible to area residents.

With an awareness of growing environmental concerns and the lack of absolute and safe solutions, we took a serious look at the concept of an Energy from Waste Facility. We realized that this proposal could contribute to the elimination of the growing mounds of garbage. We therefore felt our role as a citizens committee was not to blindly object to the plant, but to ensure that all possible safety, health and pollution controls were incorporated into the system.

The hearing was to begin in August 1985. At that time we requested a postponement of the hearing in order to raise funds, to hire legal and technical experts and to study the available data to give us a basic knowledge of the project. 3M also requested a postponement in order to receive some test results from another E.F.W. plant in P.E.I. The hearing board, realizing our financial predicament agreed to provide us with one expert, to be chosen by our group and agreed to by 3M. Although we were happy to get one of the two necessary experts, we were angry at having to make sure that 3M liked the person we chose. Fortunately 3M agreed with our choice.

We began lobbying the provincial government for intervenor funding to help us pay for our legal and technical experts. The lawyers for 3M and the Ministry of the Environment both spoke very highly to the hearing board, of our committee's credibility in being both rational and responsible in all of our previous work to date. We believe because of this support and our own hard work we, the Pottersburg Creek Pollution Committtee, were the first group in Ontario to receive intervenor funding.

In the period between the postponed and actual hearing all of the parties met to work out some of the problems and concerns, with the M.O.E. lawyer acting as an intermediary. 3M gave us access to their information and their experts to help us understand the process. 3M and their consultants set up these meetings at the convenience of my committee and worked hard to cooperate with us. These meetings were both beneficial and educational for all parties and we were able to eliminate some of the concerns and arrive at compromises that would improve the entire system. This process in turn cut down the actual hearing time and the expense and anguish to all parties involved.

I would like to give credit to the M.O.E. people in London, as they were also willing to work with us to explain the process and supply us with any information and standards that they had. The hearing board was also sympathetic to our lack of experience in attending hearings and at not being experts in this field.

During our negotiations, 3M volunteered to set up a permanent concern and complaint line for any one to have questions about the E.F.W. plant answered. Also as a condition, the test results of the 3M E.F.W. plant will be made public by the M.O.E. once a year. 3M believes that they will maintain tougher standards than the M.O.E. guidelines. I was pleased to find this out as I don't believe that this standard should be etched in stone, but you should achieve the best possible level of cleanliness.

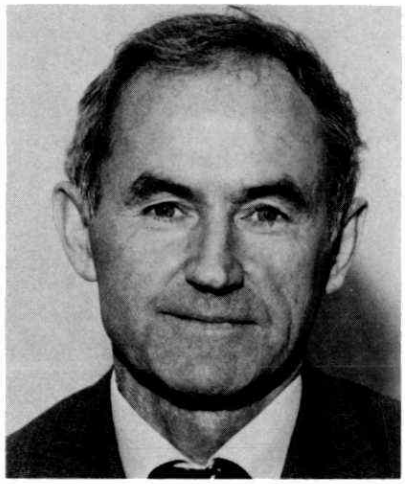
At the completion of the hearing all three parties issued a joint statement of recommendations to the Board which would become the conditions on the Certificate of Approval. My committee believes that we negotiated the best possible controls to insure the safety of the people and the environment affected by this project. In fact we feel there will be better pollution control than what now exists.

Some Areas of Importance in a Successful Approval (Proponent)

- Most of the information is highly technical and the experts tend to forget that not everyone went to the same school as they did. They seem to talk in riddles and for the ordinary lay person it is extremely embarassing to ask a question and then try to understand what he is told.
- Listening to the concerns and addressing them in a comprehensible way.
- Going out of your way to work hand in hand with all concerned parties.
- Complete openness from the beginning to avoid mistrust.
- Don't assume anything, but pretend that no one knows anything about what you are trying to do so that you can better explain yourself.
- Treat the community as an important part of your project.

- Allow the citizens time to get their funding in place before a hearing begins.
- If you are going to err, err on the side of safety. I read an article recently in regard to contaminated wild game that stated, "We don't want to scare people by saying don't eat this meat. We might find out in a year from now it's safe." What if in a year from now they find out it was not safe at all!!!
- Be rational, look at both sides of an issue and find the balance, as both sides can be confused.
- Look at the Human side of an issue to determine not only if it will work properly but also how it will affect the people.
- Generally a person's negative reaction is due to fear and lack of understanding.
- People have a "RIGHT TO KNOW", so be sure to give a complete and clear picture.

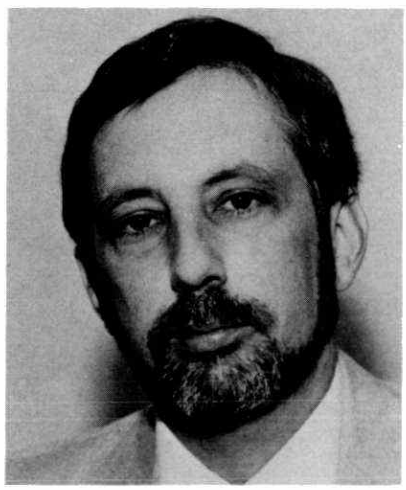
I believe that the process used by the Company, Board, Citizens and Ministry in this case should be used as a role model. We were all able to arrive at a solution that is, I believe Technically and Humanly sound. However rest assured, we the citizens will be diligent in our monitoring of the project in ensuing years.



Moderator: G.C. Ronan, Director,
Laboratory Services Branch,
Environment Ontario, Toronto

T. Crutcher, Conestoga
Rovers Consultants Inc.,
Waterloo, Ontario

G. Zikovitz, Head, Spills Action Centre,
Operations Division,
Environment Ontario, Toronto



B. Reynolds,
Regional Projects Engineer,
Environment Ontario, Ottawa

A. Douglas, Director,
Investigations and Enforcement Branch,
Environment Ontario, Toronto

POTTERSBURG CREEK PCB CLEAN-UP

by
T Crutcher, Conestoga Rovers
Consultants Inc., Waterloo,
Ontario

Mr. Crutcher spoke from notes and did not have a written text of his paper on the above subject.

No formal written text of the paper was made available by the author for inclusion in the Proceedings of the 33rd. Ontario Industrial Waste Conference.

THE SPILLS ACTION CENTRE AND ONTARIO'S SPILLS BILL

by V.G. Zikovitz, Spills Action Centre, Environment Ontario, Toronto

INTRODUCTION

On July 5, 1985 the Minister of the Environment, Jim Bradley, announced the proclamation of Part IX of the Environmental Protection Act (EPA)-commonly referred to as the Spills Bill. He also announced the development of a provincial spills centre.

Part IX of the EPA came into force on November 29, 1985. On that same day Environment Ontario's Spills Action Centre (SAC) began operations. While SAC is not an essential component of Part IX, it was considered desirable to implement its operation coincident with Part IX coming into force.

Essentially, Part IX deals with spills of pollutants to the natural environment. It places a duty on the person in control, and the owner of a spilled pollutant to clean it up regardless of who caused the spill. It also provides a compensation mechanism designed primarily to assist spill victims. In addition, Part IX establishes prompt spill notification requirements which, to a degree, have been simplified because of SAC.

SAC represents a step forward in the Ministry of Environment's (MOE's) efforts to respond effectively and consistently to spills and to deal with other urgent environmental concerns, particularly during the off-hours. It provides positive value to industry and the general public as well. Notifying the Ministry of spills is easier because of SAC's province-wide toll-free number. This number can be reached from anywhere in Ontario at any time of the day or night. As such, a spiller does not need to know the phone number of the nearest Ministry office, he simply calls SAC at 1-800-268-6060.

SAC's centralized response capabilities, with dedicated staff during all hours, enables the Ministry to fulfill its role in spills and emergencies more effectively. That role, with respect to spills, is to assess the environmental impact, ensure the spill is cleaned up, enforce our legislation and warn potentially affected parties. The Ministry's role with respect to emergencies, which constitute a danger to life or property, is to assist the agency in charge of the emergency by providing expertise and available resources.

Tougher spills legislation, the introduction of a spills centre and the clarification of MOE's role are all in keeping with increasing environmental awareness and are essential elements for ensuring the protection of Ontario's natural environment.

PART IX OF THE ENVIRONMENTAL PROTECTION ACT (EPA)

GENERAL

Part IX of the EPA deals with spills of pollutants discharged
(i) into the natural environment,
(ii) out of a structure, vehicle, or other container,
(iii) that is abnormal in quantity or quality in light of all of the circumstances of the discharge,
and that cause or are likely to cause defined adverse effects. These adverse effects are specifically defined in sec. 80 (i), (a) to (h) of the Act, and include things such as impairment of the quality of the natural environment for any use that can be made of it.

NOTIFICATION

For spills of pollutants that cause or are likely to cause adverse effects, sec. 80 of part IX requires forthwith notification by:
1. the person who has control of a pollutant that is spilled
2. the person who spills or causes or permits a spill of a pollutant.

This notification must be made to:
(i) the Ministry of the Environment
(ii) the Municipality (or Regional Municipality)
(iii) the owner
(iv) the person having control.

Essentially, there are no small quantity exemptions or minimal reportable quantities under Part IX. If the spiller believes that the spilled pollutant, regardless of the amount, has either caused or is likely to cause adverse effects then he is required to notify.

An exception to this rule exists for vehicular operating fuel spills of less than 100 l. These spills do not need to be reported provided they do not, or are not likely to enter a surface water course or water well, and that the accident was reported under the Highway Traffic Act.

Notification of spills is extremely important for various reasons. Perhaps the most important being that it provides for the opportunity to warn potentially affected parties. For example, if a pollutant has entered a water course and threatens drinking water quality, operators at water treatment plants can be contacted, and intakes closed down while the contaminant plume passes. Notification also provides the Ministry with the opportunity to assess environmental impact and to ensure the restoration of the natural environment.

CLEAN UP

For spills that cause or are likely to cause adverse effects, section 81 of Part IX requires the owner and the person having control of the spilled pollutant to "forthwith do everything practicable to prevent, eliminate and ameliorate the adverse effects, and to restore the natural environment". Essentially, the owner and the person in control are responsible for cleaning the spill up, and restoring the environment regardless of who is at fault. This provision helps to ensure that the spill gets cleaned up, and the environment is protected while arguments over who is at fault are subsequently settled.

It should be noted that prior to Part IX coming into force, the EPA was silent on any spill clean up and restoration requirements except for the provision of a Minister's order under section 16. Ministry staff responding to spills had to try and coerce the spiller into dealing with the clean up. With Part IX in place, Ministry staff can operate from a much strengthened legislated position.

COMPENSATION

Part IX also provides compensation mechanisms to assist victims of spills and those who may have incurred costs in carrying out ministerial orders or directions.

The Environmental Compensation Corporation was created under Part IX and given the mandate of assisting spill victims and where appropriate can authorize payments to those who have suffered loss or damage resulting directly from a spill.

Under certain situations, compensation payments for costs incurred in carrying out minister's orders or directions, can also be obtained from the crown under section 89 of the Act. It should be noted, however, that the owner and person having control of the spilled pollutant cannot claim under this section.

OTHER PROVISIONS

Part IX provides for the authority of the Minister to have his staff or their agents respond to spills under certain conditions in order to protect and restore the environment. It also provides the Minister with the authority to issue orders to anyone who may assist including the owner and the person having control of a spilled pollutant. In addition, municipalities are given the right to respond to spills and have the right to compensation for all reasonable costs and expenses that may be incurred.

SPILLS ACTION CENTRE

The Ministry of the Environment's Spills Action Centre receives notification of spills 24 hours per day, 365 days per year on a province-wide toll-free number **1-800-268-6060** (Toronto area business line - 965-9619). The centre also handles urgent complaints or inquiries, primarily during the hours that Ministry, Regional and District offices are closed, i.e. holidays, weekends and weekday nights.

SAC is located in Toronto at 7 Overlea Boulevard. This is in the same building as the Ministry's Central Region Office. The centre began phasing-in operations on November 29, 1985, the same day that Part IX of the Environmental Protection Act came into force.

Incoming calls are assessed by a SAC operator/officer who may refer to a series of prepared operating procedure cards for guidance. See Figures 1 and 2 for examples of what the procedure cards look like. These cards are designed to assist the operators in providing a consistent and suitable response for the various incidents that may be reported to SAC. The operator is required to record and assess the incoming information in accordance with these prescribed procedures. He/She must also decide on the appropriate action to be taken which may include the following:

1. Initiate MOE field response by contacting Regional Emergency Response Staff.

2. Contact other agencies as required, e.g. police, fire department, ambulance, Coast Guard, Canutec, municipalities, U.S. authorities, etc.

3. Ensure that potentially affected parties are notified/warned.

4. Notify senior MOE management of serious incidents and coordinate information flow with the Communications Branch.

5. Establish contact with the Minister regarding major incidents and convey orders or directions from the Minister where necessary.

6. Liaise with and coordinate Ministry support for agencies in charge of emergency situations.

7. Provide information on chemicals and clean-up techniques to MOE staff and others.

8. Record details of non-urgent incidents and forward to relevant District Offices or other agencies for response during normal business hours.

The Spills Action Centre was designed to handle roughly 12,000 incidents per year (or 1000 per month). It was anticipated that roughly 10,000 of these calls would be either complaints or inquiries, with the remaining 2000 being spills. After an initially slow start during the period in which operations were being phased in, SAC reached its theoretical operating capacity in its sixth month of operation. See Figure 3. During the month May, 1986, SAC handled a total of 995 incidents, 495 of which were spills. It should be noted however, that many of these spills (129), were considered to be minor discharges to air.

The SAC operating procedures are updated as experience is gained. It is anticipated that, in time, SAC will become a repository for technical information and data pertaining to spills, including possible clean-up and restoration details for legal and quasi-legal purposes. SAC is of positive value to industry and the public in that it provides a single province-wide, toll-free contact number that can be reached any time of the day or night. It also provides this Ministry with an improved, systematic approach for dealing with environmentally urgent matters.

Figure 1

PRIMARY ASSESSMENT OF INCIDENT

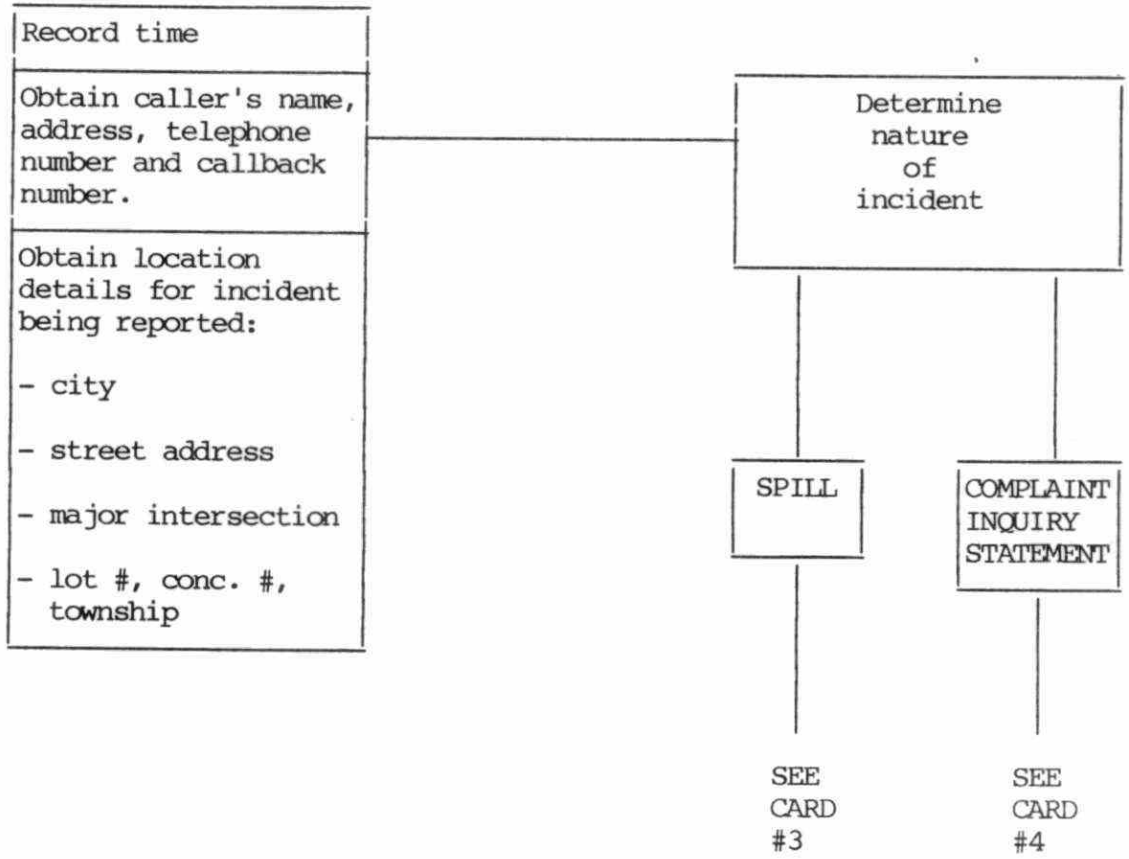
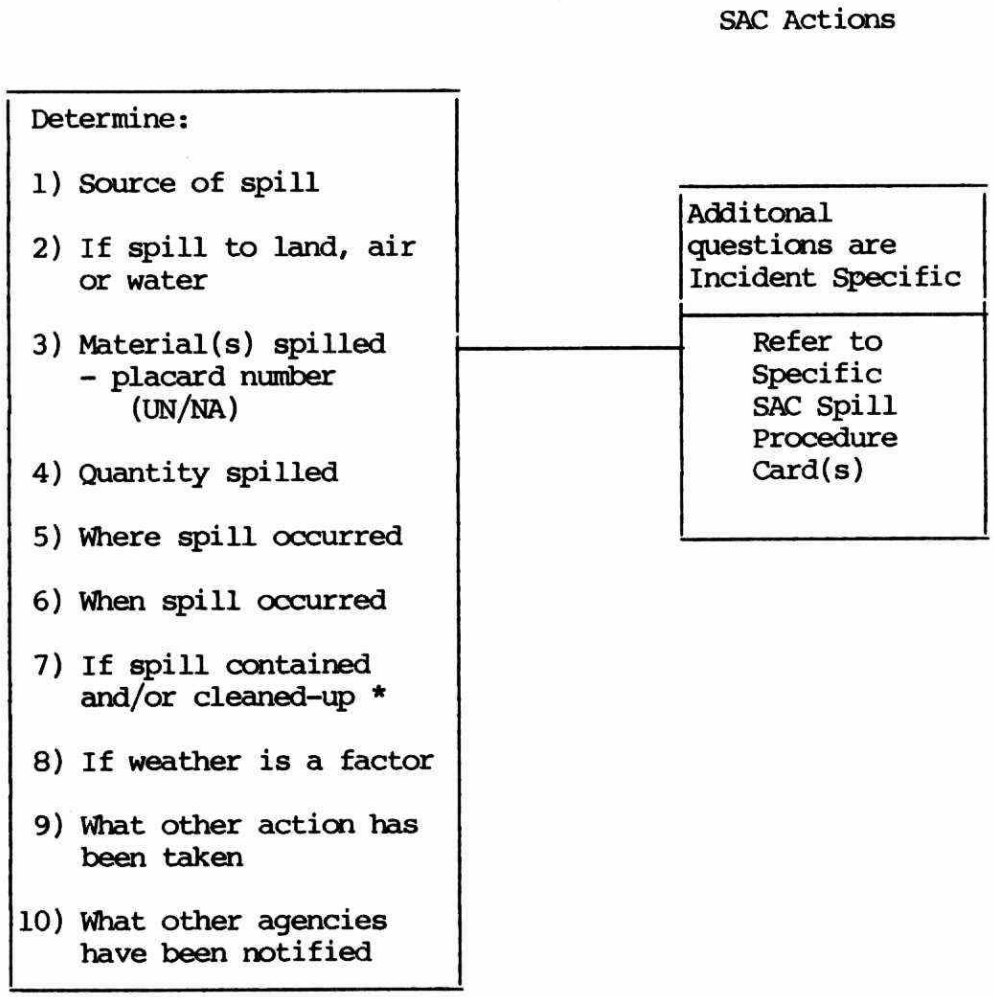


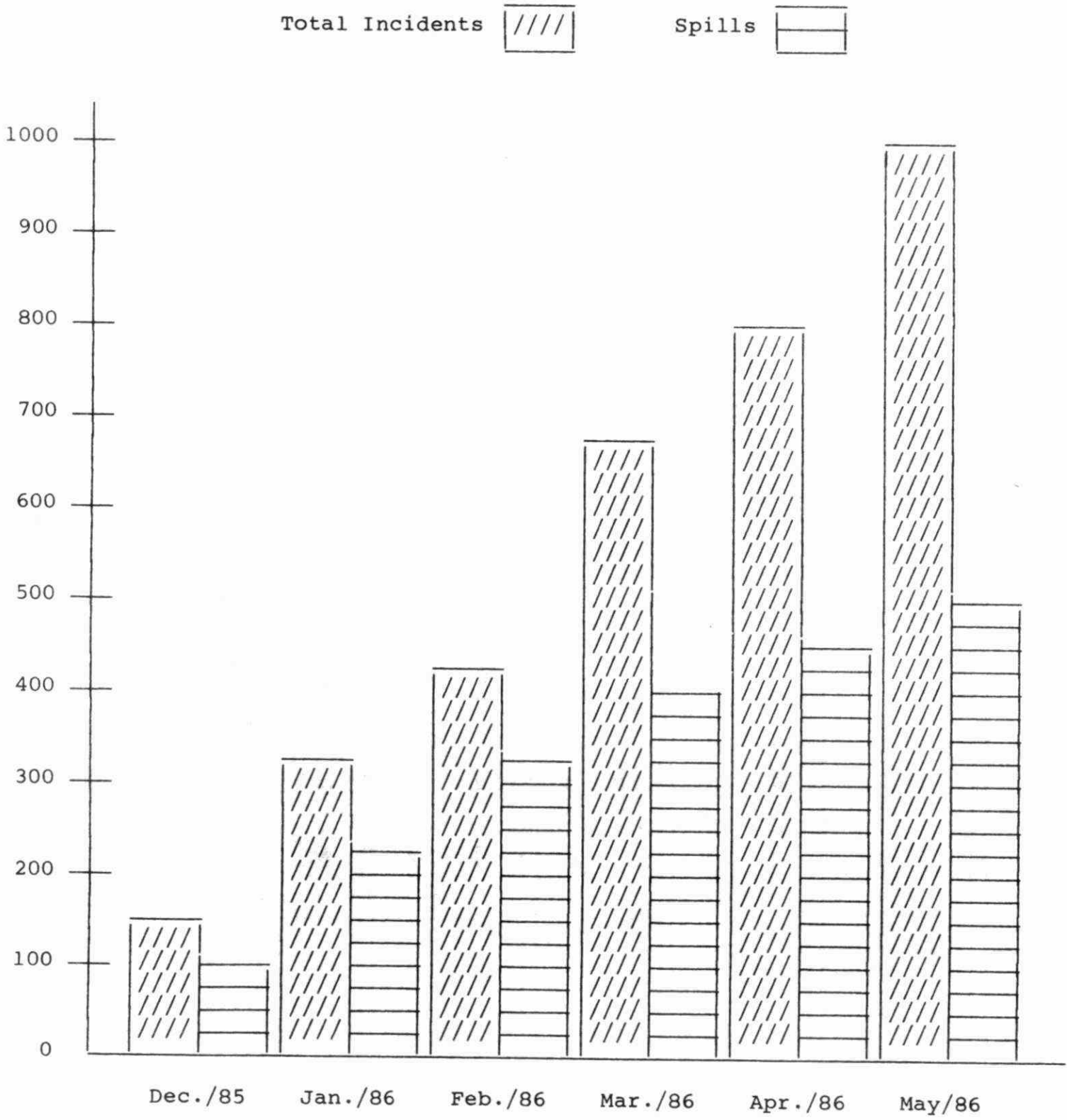
Figure 2

PRIMARY ASSESSMENT OF SPILLS



* Section 81 Environmental Protection Act places responsibility on the owner and person in control to clean up a spill.

Figure 3 SAC Incident Summary



ROLE OF THE MINISTRY IN EMERGENCIES AND SPILLS

Early in 1986 the Ministry issued a policy statement which decribes its role as "in protecting life, property, and the environment during emergencies and spills". An emergency is described as "a situation caused by forces of nature, an accident, an intentional act or otherwise that constitutes a danger of major proportion to life or property". The definition of a spill in this policy statement is the one used in Part IX.

During emergencies, the Ministry's role is to assist the agency in charge or in control of the emergency by providing advice or assistance in accordance with the Ministry's available expertise and resources. The Ministry will also provide available monitoring assistance at the request of the person in charge.

Collectively the MOE has considerable expertise and monitoring capabilities to help deal with emergencies that may arise. These resources, however, are frequently some distance from the incident being reported, and are subject to the availability of staff during the off-hours. As a Ministry, we do not maintain a 24 hour response capability for all types of emergencies that may be encountered. Responsibilities for taking control of emergencies are set out in the Emergency Plans Act, and Order in Council 1770/85. The MOE will support and advise those agencies that are in control of emergencies.

During spills, the role of the Ministry is to assess the environmental impact of spills, and as regulatory agency, enforce the duties and provisions imposed by any applicable legislation administered by the Ministry. Essentially, the Ministry receives spill reports, notifies other agencies, attempts to warn downstream users or potentially affected parties, and ensures that the spill is cleaned up, and the environment is restored.

With respect to spills, Ministry staff will also advise and recommend on appropriate clean up and disposal measures. Most spills, however, have been and continue to be cleaned up by the spiller. MOE's involvement is frequently limited to confirming the effectiveness of the clean up, and seldom involves making actual clean up arrangements. Ministry staff will also make recommendations with respect to procedures or equipment to help reduce the likelihood of future spills.

WASTES FROM THE HIGH TECH INDUSTRY

by B. Reynolds, Regional Projects Engineer, Environment Ontario, Ottawa

INTRODUCTION

About a year ago the Ontario Ministry of the Environment established a working group to investigate the environmental impact of the electronics industry in Ontario. The Working Group consists of myself as Chairman and full-time worker on the project and representatives from Water Resources, Air Resources, Approvals, Laboratory Services and Hazardous Contaminants Branches. Today I will bring you up-to-date on what we've learned in the first year of this three year project.

I would like to start off by clearing up two common misconceptions about the High Tech or Electronics Manufacturing Industry.

NUMBER 1 It is a clean industry.

The electronics industry has the reputation and appearance of pristine cleanliness and cleanliness in the manufacturing area is essential to produce microelectronic devices. This interior cleanliness is achieved, however, by the use of large quantities of solvents and cleaners to remove contaminants from the workplace and some are released into the environment or sewer systems where they become our concern.

NUMBER 2 It is a mechanical or physical processing industry

Microelectronic devices are manufactured almost entirely by chemically depositing layers of various materials to build up complex three dimensional circuitry. The industry is highly chemical intensive.

Electronics manufacturing includes the following four industry sectors:

(a) Computing Equipment
(b) Telecommunications Equipment
(c) Electronic Components
(d) Electronic Instrumentation

The electronic components sector is of greatest environmental concern and includes Semiconductor Manufacturing (SCM) and Circuit Board Manufacturing (CBM) and the assembly of these components into a useful device. Although all sectors are of environmental concern, my talk today will concentrate on the manufacture of these components into useful devices.

Within Canada, approximately 2/3 of electronic manufacturing takes place in Ontario. Within Ontario the Ottawa area is the center of Semiconductor Manufacturing with some industry located in the Ministry's Central and West Central Regions. About 70% of Circuit Board Manufacturing is done in the Toronto area with some industry in the Southeast and West Central Regions.

There are several factors which make waste streams from CBM & SCM extremely complex:

(1) Subtractive processing is used which involves coating a board or wafer with a layer of material and etching, stripping or dissolving the material from areas where it is not wanted, resulting in large quantities and varieties of waste streams.

(2) Market demands for more intricate and compact electronic devices have given rise to the evolution of numerous specialized chemicals and chemical mixtures to meet rigid quality control requirements.

(3) Over a thousand proprietary chemical formulations are in use in the industry in Ontario and quite often the ingredients of these chemicals are closely guarded secrets. This makes approvals and assessment procedures very difficult.

SEMICONDUCTOR MANUFACTURING

Simply stated, a semiconductor is a crystalline solid such as silicon or gallium arsenide which has small amounts of impurities or dopants inserted into the crystalline structure to create negative and positive junctions. An integrated circuit is a number of semiconductor devices interconnected on a single chip. Optoelectronic devices such as Light Emitting Diodes, solar cells and photovoltaic cells are specialized semiconductors and often use a gallium arsenide substrate.

The following description of the processes involved in the manufacture of an integrated circuit is a simplistic view of a very complex process.

(1) OXIDATION: A layer of silicon dioxide is formed on the wafer.

(2) PHOTORESIST APPLICATION: A photosensitive polymer in a solvent carrier is applied to the wafer. Polymer solvents (n-butylacetate, cellosolve acetate, xylene, ethylbenzene etc.) evaporate off.

(3) MASKING AND EXPOSURE: The wafer is exposed to ultraviolet light through a circuit photo. Positive photoresists become more soluble upon exposure while negative resists become less soluble.

(4) DEVELOPING: The wafer is washed in solvents to remove the soluble photoresist thus exposing the underlying silicon dioxide in the desired circuit pattern.

(5) ETCHING: The exposed silicon dioxide is then removed from the wafer by wet or dry chemical etching. Wet etching uses strong acids principally hydrofluoric acid. There are numerous dry etching processes which all involve etching with a variety of gases energized into a highly reactive state. Freon plasma etching is most common.

(6) PHOTORESIST STRIPPING: The hardened photopolymer is then removed by wet chemical stripping (strong acids, caustics or organic strippers).

(7) DOPING: Dopant atoms are injected into the wafer surface by diffusion or ion implantation. Diffusion involves exposing the wafer to gaseous dopants in a furnace where the dopant atoms are allowed to penetrate the surface. Ion implantation uses a particle accelerator to fire ionized atoms at the wafer surface. Where the wafer is still coated with silicon dioxide, dopants are prevented from penetrating.
Negative dopants include a variety of arsenic, phosphorus and antimony compounds including arsine, phosphine, and antimony trichloride. Diborane and boron trichloride are typical positive dopants.

(8) OXIDE ETCH: The remaining silicon dioxide is then etched away.

(9) DEPOSITION: Additional layers of silicon based material can be deposited on the wafer surface by deposition processes. Silane, chlorinated silanes, silane dopant mixtures, and silane ammonia mixtures are used to deposit the desired layers of silicon, doped silicon and silicon nitride.

(10) METALLIZATION: Interconnection between various circuit components is normally done by flash evaporating the metal, allowing it to deposit on the wafer and etching it again using the photoresist, exposure, development and stripping processes previously described.

Silicon Valley California

It was only 5 years ago that the High Tech Industry's environmental reputation became tarnished. Silicon Valley (Santa Clara County) in Central California is the center of Semiconductor Manufacturing in the United States and has 650 electronics manufacturers including 120 semiconductor plants.

About 100 aquifer contamination sites have been discovered in the County in the past five years mainly caused by leaking underground solvent storage tanks. Nineteen of these sites are on the EPA Superfund list of which eighteen are High Tech related, mostly semiconductor firms. Cleanup costs are estimated to be greater than $200 million dollars. Santa Clara county has more Superfund sites than any other County in the United States.

Electronics manufacturers generate about 50% of the hazardous waste for off-site disposal in the county (50,000 tons/yr.). In addition 10 million tons/yr. of hazardous waste is treated on-site.

It is estimated that 5 tons/day of precursor organic compounds are emitted to the air from the semiconductor industry in Santa Clara county.

Specific regulations and rules have been enacted in the Country to control leaks from underground storage tanks and air emissions from the industry and considerable work has been done to characterize waste streams. Much of our knowledge of the industry has been obtained from California sources in addition to what we have learned from representatives of the industry in Ontario.

SCM in Ottawa Area

The Ottawa area has 8 semiconductor manufacturers, 5 silicon, 2 gallium arsenide, and one of both. Having assessed all these plants the following are some observations:

(1) In the Ottawa area none of the companies assessed use underground storage for either chemicals or wastes and they are not in communities using groundwater supplies. We should, therefore, not be subject to the aquifer contamination problems encountered in California.

(2) All generate substantial quantities of hazardous wastes including chlorinated solvents, unchlorinated solvents, freons, photoresist developers and strippers, and contaminated vaccum pump oils. Total hazardous waste generated is estimated to be 10,000 kg/month for off-site disposal.

(3) Only one of the 8 has Ministry approval for air emissions which was granted in 1984. This is the first in the province to my knowledge. The Ministry now has several applications for approval under review.

(4) Because of the rapidly advancing technology all firms have an R & D component to them. They are, therefore, testing new chemicals and processes constantly. They may have several hundred different chemicals on hand and as many as 100 proprietary chemical mixtures.

The MOE air approvals process of developing ambient air standards for every chemical they use is not feasible given the large number of chemicals and the new chemicals coming into use. Some flexibility in our Approvals approach is necessary.

(5) The industry is very dynamic. During my investigations 5 of the 8 companies had imminent plans for expanding, changing processes, adding new processes etc. We now have 5 applications for approval of air emissions in the works and numerous chemicals of most environmental concern now have ambient air standards or are in the process of review. This will make future applications much easier to assess.

(6) The industry is very aware of the hazardous nature of the chemicals they are using and Occupational Health and Safety is a high priority.

Past Problems

What kind of problems have we had in the past with the industry?

(1) Two sewer collapses due probably to low pH discharges.

(3) There have been some noise and odour complaints which were resolved.

(4) There was leakage from several drums of Trichloroethylene improperly stored and several other chemical spills or leaks.

Environmental Concerns

(1) Hazardous chemical storage, handling, and disposal is a major concern within the industry. The companies appear to be doing a good job in this area.

(2) Air emissions are also of concern and there is a lot more that the Ministry should know about these chemicals in order to properly assess an operation:

- Dopant, etchant and deposition gases are used in small quantities but are very toxic.
- Gaseous hydrogen chloride and hydrofluoric acid generate acid fumes.
- Arsine and other arsenic compounds are of great concern.

(3) Sewer discharges are of minimal concern but stripping solutions (organic acids) and developers (tetramethyl ammonium hydroxide) are often sewered. Fluorides and pH are also of concern.

CIRCUIT BOARD MANUFACTURING (CBM)

Introduction

In the past 10 years the single sided circuit board (circuitry on one side only) has been replaced by double-sided boards where circuitry on each side of the board is electrically connected through holes in the board. The requirements for more compact boards have resulted in the past few years in the increasing popularity of multilayer boards, which are several double-sided boards sandwiched together.

Manufacturing Process

The manufacturing processes vary but the following processing sequence is typical of most operations:

(1) A copper-clad epoxy glass is cut to size and drilled.

(2) After the board has been sensitized in a palladium tin catalyst, copper is plated on the interior of the drill holes by electroless copper deposition, which involves the reduction of copper ions by formaldehyde.

(3) A light sensitive polymer (photoresist) is applied to the board.

(4) The board is covered with a photograph (mask) of the desired circuitry and exposed to ultraviolet light.

(5) The board is washed in a developer solvent which removes the soluble photoresist exposing underlying copper in the desired circuit pattern.

(6) Copper is electroplated onto the surface of the exposed copper to build up circuitry.

(7) Tin-lead is then electroplated on to the exposed copper.

(8) The remaining photoresist is chemically stripped from the board either with caustic or an organic stripper (usually 1,1,1-trichloroethane).

(9) The background copper is removed by a chemical etchant such as ammonium persulphate. The tin-lead layer protects the copper circuitry from the etchant.

(10) A fusing fluid is applied to the board and the tin-lead solder is reflowed in an infra-red oven.

(11) The tin-lead is stripped from the tabs (electrical external connections).

(12) The tabs are nickel plated and gold plated.

(13) After a solder mask has been applied components are plugged into the board and soldered into place in a wave soldering process.

A typical Circuit Board operation would consist of approximately 50 process tanks, including 20 rinse water, 8 acid baths, 3 etch tanks, 3 alkaline cleaners, 5 plating baths, and 11 other proprietary chemical baths (catalysts, brighteners, cleaners, conditioners, antioxidants, etc.).

CBM Metal Wastes

Metal wastes per square meter of board produced can be calculated quite readily. Knowledge of the production levels and waste treatment processes can then be used to determine the eventual fate of waste metals.

Not including the major portion of copper in the waste etchant which is normally recycled via the chemical supplier, the following are typical metal loadings from a plant producing 100 m^2 of board per day (a medium-large plant).

Cu	1.7	kg/day
Sn	0.20	
Pb	0.12	

A multilayer facility of 100 m^2/day using chromic acid as an expoxy stripper and tin-lead stripping on interior boards would generate the following metal loads:

Cu	1.7	kg/day
Sn	1.5	
Pb	1.0	
Cr	2.7	

These loadings can be dramatically reduced through on-site waste treatment or waste haulage, however, due to the high rinse water usage, sewer-use by-law compliance is feasible with little pretreatment or haulage. Some simple calculations can be made to show that metal loading from a medium-sized CBM could have a dramatic effect on the operation of a small sewage treatment plant.

Hazardous wastes that may be generated by a CBM include solvents, developers, strippers, copper etchant, electroless copper overflow, chromic and fluoroboric acids, solder strippers, fluxes, fusing fluids and wave oils.

CBM in the Ottawa Area

There are 14 CBMs which have been assessed in the Ottawa area, 11 small and 3 medium. The following are some observations about the industry.

(1) All generate substantial quantities of hazardous waste and use a wide variety of hazardous chemicals.

(2) In Ottawa they are generally small companies with little knowledge of hazardous chemicals. They operate from a recipe provided by the chemical supplier. This observation may not be true of larger shops in Toronto area.

(3) Most wastes are sewered after batch neutralization. Some wastes which have commercial value are recycled via the supplier.

(4) Generally operations were somewhat sloppy with little concern for the environment.

(5) The smaller companies are on shoestring budgets with little money available for pollution control.

(6) Of the 3 medium sized companies, one has air approvals and a good waste treatment system. The other two are in the process of putting in waste treatment systems and applying for air approvals

Past Problems

(1) The sludge digestion process at one of the Ottawa sewage treatment plants was wiped out by a copper discharge to the sewers. A High Tech firm was suspected but this was never confirmed.

(2) A CBM set up shop in the basement of a building, discharged their wastes to the concrete floor where they flowed to a floor drain and then were pumped to the storm sewer. The floor eventually corroded and chemicals ended up in the soil. The company folded up leaving a mess which had to be cleaned up by the building owner.

(3) A company has accumulated over 100 drums of mixed wastes referred to as chemical soup and is now in the process of trying to properly dispose of them.

Environmental Concerns

(1) Hazardous chemical storage, handing and disposal is the major concern. There is a great deal of room for improvement in this area.

(2) Heavy metal discharges to sewers are also a major concern. High rinse water volumes can dilute metals to the point where very little treatment or waste haulage is required to meet sewer use by-law concentration limits.

(3) Several process steps require separate venting and air emission approvals but air emissions are not a major environmental concern.

OTHER HIGH TECH INDUSTRIES

There are about 130 electronics manufacturers in the Ottawa area of which about 65 are generators of hazardous wastes. Very few of these have received Ministry air approval in the past.

Because of the special focus on the High Tech Industry in the Ottawa area we now have about 20 applications for air approvals in the works. This will increase our knowledge of the different industry sectors tremendously.

Some other types of electronics manufacturers of environmental concern are Military and Aerospace, Telecommunications, Hybrid Circuits, Assemblers (wave soldering), Instrumentation, Fiber Optics, etc.

FUTURE TRENDS IN ELECTRONICS

There are several trends in processing technology which will have an environmental impact.

(1) Gallium arsenide is expected to take over a larger market share from Silicon Chips since it can process data more quickly and efficiently. Concerns over arsenic will have to be addressed.

(2) Plasma etching is taking over from wet etching. This reduces hazardous waste generation but the nature of air emissions is not fully understood.

(3) Positive photoresists are replacing negative photoresists. This will generate less hazardous organic solvent waste but will use inorganic developers which are normally sewered.

(4) Multilayer boards are taking some of the market share from double sided boards. This will result in more tin-lead and chromium wastes.

PROJECT SCHEDULE

What have we accomplished in Year 1 of the project?

(1) We have learned a lot about the chemicals in use in the industry and their emission rates to the environment. Contaminant mass balances are available for some industry sectors and in the works for other sectors.

(2) We have assessed most of the Ottawa area industry and there has been a great improvement in their compliance with environmental legislation and standards.

(3) Contacts have been made with industry trade associations, chemical suppliers etc. to make the Ontario industry more aware of environmental legislation.

(4) Many chemicals commonly used in the industry have had ambient air standards developed and we are now in a better position to assess applications for Certificates of Approval to regulate air emissions.

What do we expect to accomplish in Year 2:

(1) Further assessments of plants in the Southeast Region outside of the Ottawa area will be conducted.

(2) Chemical usage data, air emission data from Air Approvals applications, and hazardous waste data from generator registration will be put together for various industry sectors to provide contaminant mass balances.

(3) Information gathered so far will be provided to West Central and Central Region through personnel already designated for that task. This will aid them in assessments of existing and proposed plants in their areas.

(4) A committee will be set up to properly categorize hazardous wastes from the electronics industry to aid staff in assessing generator registration reports.

Year 3

(1) We should be in a very good position to assess the overall enviromental impact of electronics manufacturing in Ontario and make recommendations for improvements.

(2) We plan to provide a comprehensive report which would explain the processes used by the various electronics industry sectors, the associated environmental concerns and suggested control technologies. This could be used as a Code of Good Practice for the industry and an assessment tool for Ministry staff.

The electronics manufacturing industry is still small in Ontario but the rapid growth rate and complexity of the industry dictates that a special effort be made to prevent future environmental problems from occurring. An up-to-date knowledge of today's processes and tomorrow's trends is essential in achieving this. This has been a very interesting project for me and the other members of the electronics manufacturing working group and I am sure that some real benefits to our environment will come out of it through better control of air emissions and waste management practices by the Ministry and the industry.

ENVIRONMENTAL ENFORCEMENT IN ONTARIO

by A. Douglas, Director, Investigations
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I WOULD LIKE THANK THE ORGANIZERS OF THIS CONFERENCE FOR THE INVITATION TO JOIN YOU THIS MORNING AND TO HAVE THE OPPORTUNITY TO OUTLINE THE ROLE AND ORGANIZATIONAL STRUCTURE OF THE MINISTRY'S NEW INVESTIGATIONS AND ENFORCEMENT BRANCH.

THE PHILOSOPHY BEHIND THIS BRANCH AND ITS EXPANDING OPERATIONS DESERVES BRIEF MENTION.

IN ONTARIO, AS ELSEWHERE, PEOPLE ARE BECOMING MORE CONCERNED ABOUT WHAT THEY PERCEIVE TO BE POLLUTION -- NOT ONLY WHAT THEY CAN SEE WITH THEIR OWN EYES, BUT THE SO-CALLED INVISIBLE POLLUTION IN AIR, WATER AND SOIL.

THE PUBLIC ARE FAR MORE ENVIRONMENTALLY AWARE NOW THAN EVER BEFORE IN OUR HISTORY. POLLUTION, TO SOME, IS NOT ONLY AN AFFRONT, BUT A SERIOUS CRIME.

IN RESPONSE TO GROWING PUBLIC CONCERNS, THE MINISTER OF THE ENVIRONMENT ANNOUNCED IN JUNE OF 1985 THE CREATION OF THE NEW BRANCH AND GAVE IT A STRONG MANDATE OF BEING RESPONSIBLE FOR ALL ASPECTS OF ENFORCEMENT WITHIN THE MINISTRY.

THE ANNOUNCEMENT OF THIS NEW BRANCH REINFORCED THE GOVERNMENT'S COMMITMENT THAT ILLEGAL POLLUTION WILL NOT BE TOLERATED WITHIN THE PROVINCE. BY PROVIDING THE MINISTRY WITH THE RESOURCES TO INITIATE AND CONTINUE WITH AN EFFECTIVE ENFORCEMENT PROGRAM, THE GOVERNMENT HAS DEMONSTRATED ITS FIRM COMMITMENT TO ADMINISTERING ENVIRONMENTAL LAWS.

REPORTING THROUGH THE ASSISTANT DEPUTY MINISTER OF THE OPERATIONS DIVISION, THE BRANCH WAS ASSIGNED THE TASK OF DEVELOPING A PRO-ACTIVE ENFORCEMENT PROGRAM TO SEEK OUT AND ACT UPON ENVIRONMENTAL INFRACTIONS.

THE BRANCH WAS GIVEN THE FOLLOWING OBJECTIVES:

1. TO CONDUCT INVESTIGATIONS OF AND PREPARE PROSECUTIONS FOR ILLEGAL ACTIVITIES IN THE PRIVATE AND PUBLIC SECTORS;

2. TO SUPPLY INFORMATION IN SUPPORT OF PROSECUTIONS.

PROSECUTIONS WILL BE INITIATED AT THE FIELD LEVEL WITH LIMITED SENIOR MANAGEMENT APPROVAL. THIS APPROACH IS USED IN ALL POLICE-TYPE AGENCIES ACROSS CANADA. THIS POLICY CHANGE IS INTENDED TO ENSURE OBJECTIVITY AND REMOVE THE POSSIBILITY OF ALLEGATIONS OF BUREAUCRATIC INTERFERENCE.

IT MUST BE SAID THAT WE ARE UNDER NO CONSTRAINTS AS TO WHOM WILL BE INVESTIGATED AND WHOM WILL BE CHARGED. THIS IS STRAIGHT POLICE WORK.

YOU NO DOUBT SAW THE MEDIA REPORTS WHEN OUR OFFICERS DECIDED TO RECOMMEND PROSECUTION OF ANOTHER BRANCH OF THE ONTARIO GOVERNMENT. RECENTLY, WE BROUGHT CHARGES AGAINST A MAJOR PUBLIC UTILITY. WE HAVE INVESTIGATED AND CHARGED MUNICIPALITIES, AND WILL CONTINUE TO DO SO WHEN THE CIRCUMSTANCES DEMAND IT.

WE ARE PLAYING NO FAVORITES, AND NONE OF OUR POLITICAL MASTERS HAS SUGGESTED THAT WE DO. I MUST SAY THAT THIS FREEDOM OF ACTION GIVES ME A GOOD FEELING TOWARDS OUR TASK.

WE WERE AUTHORIZED TO RECRUIT 63 PERSONNEL FOR THE NEW BRANCH WHICH INCLUDED 42 INVESTIGATORS TO BE LOCATED IN 15 MINISTRY OFFICES ACROSS THE PROVINCE.

A SPECIAL TASK FORCE OF EIGHT INVESTIGATORS, HEADED BY A MANAGER REPORTING TO THE ASSISTANT DIRECTOR OF THE BRANCH, HAS ALSO BEEN CREATED.

THIS TASK FORCE OPERATES ACROSS THE PROVINCE AND INITIATES INVESTIGATIONS IN THE MOST SENSITIVE ENVIRONMENTAL AREAS. THE TASK FORCE WILL ALSO UNDERTAKE INVESTIGATIONS INVOLVING THE MOVEMENT OF WASTE ACROSS OUR PROVINCIAL BOUNDARIES.

WE HAVE BEEN GIVEN SOLID SUPPORT FROM OUR MINISTRY FROM THE START. OUR LEGAL SERVICES BRANCH HAS GROWN RIGHT ALONG WITH US. I BELIEVE THEIR STAFF OF PROSECUTORS HAS NEARLY DOUBLED IN THE LAST YEAR.

WE AND THEY CAN TAKE SOME SATISFACTION FROM THE NUMBER OF CASES WHICH HAVE GONE TO TRIAL OR ARE PENDING. IN THE FISCAL YEAR 1984-85, THERE WAS A GRAND TOTAL OF 54 PROSECUTIONS. IN THE 1985-86 FISCAL YEAR, KEEPING IN MIND THAT THE BRANCH WAS NOT FULLY OPERATIONAL UNTIL NOVEMBER 1985, WE INITIATED 86 PROSECUTIONS.

OUR INVESTIGATORS ARE CONDUCTING A LARGE NUMBER OF ONGOING INVESTIGATIONS.

WE HAVE BEEN FORTUNATE TO ATTRACT INDIVIDUALS TO THE MANAGEMENT POSITIONS IN THE BRANCH WHO BRING A WIDE VARIETY OF INVESTIGATIVE AND ENVIRONMENTAL EXPERIENCE.

I PERSONALLY HAVE HAD OVER 30 YEARS EXPERIENCE IN THE INVESTIGATIVE AND ENFORCEMENT AREA WITH THE METROPOLITAN TORONTO POLICE DEPARTMENT.

OUR ASSISTANT DIRECTOR BRINGS WITH HIM SOME 25 YEARS EXPERIENCE WITHIN THE ONTARIO GOVERNMENT AND HE HAS BEEN WITH THE MINISTRY OF THE ENVIRONMENT SINCE IT WAS FORMED IN 1972.

THE MANAGER OF FIELD OPERATIONS HAS AN EXTENSIVE POLICE BACKGROUND, WITH SOME 32 YEARS EXPERIENCE WITH THE METROPOLITAN TORONTO POLICE DEPARTMENT.

OUR TASK FORCE LEADER BRINGS HIS EXPERIENCE AS A FORMER MINISTRY ABATEMENT OFFICER AND OUR ENFORCEMENT, POLICY AND INTELLIGENCE CO-ORDINATOR, FORMERLY WITH THE ROYAL CANADIAN MOUNTED POLICE, HAS JOINED THE BRANCH TO TAKE ON THE RESPONSIBILITY OF DEVELOPING OUR TRAINING PROGRAM AND THE ESTABLISHMENT OF VARIOUS INFORMATION SYSTEMS WITHIN THE BRANCH.

WE HAVE ALSO ESTABLISHED A UNIT IN THE BRANCH KNOWN AS THE AERIAL AND GROUND SURVEILLANCE UNIT WHICH EMPLOYS THE USE OF SOPHISTICATED AERIAL PHOTOGRAPHIC EQUIPMENT IN THE DETECTION AND OBSERVATION OF EMISSIONS OR SPILLS TO BOTH AIR AND WATER.

WE ARE ASSISTED IN THIS ACTIVITY BY THE UTILIZATION OF THE VOLUNTARY SERVICES OF THE NINETY-NINES INCORPORATED, AN INTERNATIONAL ORGANIZATION OF WOMEN PILOTS.

I FEEL VERY FORTUNATE IN HAVING BEEN ABLE TO ATTRACT TO THE BRANCH WHAT I BELIEVE IS A VERY COMPETENT INVESTIGATIVE STAFF IN THE FIELD, FROM WITHIN THE MINISTRY AND OUTSIDE ENFORCEMENT AGENCIES.

IT IS OUR INTENTION TO BRING TOGETHER THE ENVIRONMENTAL EXPERIENCE OF EXISTING STAFF AND THE ON-THE-GROUND INVESTIGATIVE CAPABILITY OF THOSE WHO HAVE JOINED THE MINISTRY FROM OUTSIDE ENFORCEMENT AGENCIES INTO AN EFFECTIVE ENFORCEMENT GROUP CAPABLE OF DELIVERING OUR MANDATE.

THE ADDED RESOURCES AVAILABLE IN THE MINISTRY DEVOTED TO ENFORCEMENT WILL ALSO ALLOW US TO ENHANCE OUR EXISTING ABATEMENT PROGRAMS.

PREVIOUSLY, ABATEMENT OFFICERS WERE REQUIRED TO WEAR TWO HATS -- THEY WERE TO WORK WITH INDUSTRY IN DEVELOPING ENVIRONMENTAL CONTROL PROGRAMS IN A CO-OPERATIVE APPROACH AND ON THE OTHER HAND THEY WERE CALLED ON TO GATHER EVIDENCE AND INITIATE PROSECUTIONS.

STAFF FOUND THEMSELVES IN CONFLICTING ROLES OF NEGOTIATOR AND ENFORCER. THE CREATION OF THIS NEW BRANCH RESOLVES THIS CONFLICT AND ALLOWS US TO INCREASE OUR POLLUTION MONITORING AND ABATEMENT ACTIVITIES ON THE ABATEMENT SIDE AND GIVES US THE ADDITIONAL RESOURCES TO UNDERTAKE INVESTIGATIONS AND PROSECUTIONS.

MANY ABATEMENT OFFICERS, UNDER THE OLD RULES OF PROCEDURE, WERE RELUCTANT TO ABANDON THEIR ATTEMPTS AT CO-OPERATIVELY DEVELOPING CONTROL PROGRAMS WITH POLLUTING INDUSTRY. TO PROCEED TO THE NEXT STEP -- THE ULTIMATE STEP OF RECOMMENDING PROSECUTION -- SEEMED ALMOST LIKE A CONFESSION OF FAILURE.

THAT PERFECTLY UNDERSTANDABLE DILEMMA HAS NOW BEEN RESOLVED. THERE WILL BE NO LESSENING OF ATTEMPTS TO DEVELOP CO-OPERATIVE CONTROL PROGRAMS WHERE THERE ARE REASONABLE PROSPECTS OF SUCCESSFUL RESULTS IN ABATEMENT. THAT IS CERTAINLY THE PREFERRED COURSE. BUT WHEN NEGOTIATIONS ARE UNREASONABLY PROTRACTED, OR WHEN THEY BREAK DOWN, THE ABATEMENT OFFICER HAS THE RECOURSE OF TRANSFERRING THE PROBLEM TO US.

TO FURTHER REINFORCE THE MINISTRY OF THE ENVIRONMENT'S COMMITMENT TO PROVIDING A UNIFORM APPROACH FOR ENFORCING ITS ACTS AND REGULATIONS, THE MINISTER, THE HONOURABLE JAMES BRADLEY, RECENTLY ANNOUNCED A NEW POLICY OF THE MINISTRY.

THE POLICY WHICH IS KNOWN AS "UNIFORM ENVIRONMENTAL ENFORCEMENT" BECAME EFFECTIVE MAY 6, 1986.

THE POLICY SETS OUT THE PRINCIPLES AND PROCEDURES THAT WILL BE USED BY MINISTRY STAFF IN ASSURING THAT ENVIRONMENTAL STATUTES ARE UNIFORMLY ENFORCED.

THE MINISTRY HAS CLEARLY SET OUT THAT PROSECUTIONS UNDER ENVIRONMENTAL STATUTES WILL BE A RESULT OF INFORMED JUDGMENT TO ASSURE AN NON-DISCRIMINATORY AND EVEN-HANDED APPROACH.

WHERE THERE ARE IMPORTANT REASONS WHY A PROSECUTION WOULD BE INAPPROPRIATE, THE MINISTRY WILL EXERCISE PROSECUTORIAL DISCRETION, HOWEVER, THE REASONS FOR THE DECISION WILL BE RECORDED FOR FUTURE REFERENCE.

THE MINISTRY WILL ALSO SEEK PENALTIES UPON CONVICTIONS OF POLLUTERS WHICH WILL BE COMMENSURATE WITH THE SERIOUSNESS OF THE OFFENCE.

WE WILL RELY ON A VARIETY OF CONSIDERATIONS IN OUR DETERMINATION AS TO WHETHER PROSECUTIONS WILL PROCEED OR WHETHER OTHER POLLUTION ABATEMENT REMEDIES ARE MORE APPROPRIATE.

DECISIONS WILL BE BASED UPON WHETHER THE VIOLATION OF THE LEGISLATION POSES A SIGNIFICANT RISK TO HUMANS OR THE ENVIRONMENT.

THE MINISTRY WILL CONSIDER WHETHER THE POLLUTION CAUSING THE VIOLATION SERIOUSLY JEOPARDIZES THE ACHIEVEMENT OF MINISTRY AIR QUALITY OR WATER QUALITY OBJECTIVES.

DURING THE INVESTIGATIVE PHASE OF THE DECISION MAKING PROCESS, INFORMATION PERTAINING TO WHETHER THE VIOLATION INVOLVED CONCEALMENT OF INFORMATION, DISREGARD FOR WARNINGS, NEGLIGENCE OR WHETHER A DELIBERATE ACT WAS COMMITTED WILL ALL BE PART OF THE MINISTRY'S REVIEW WHEN CONSIDERING WHETHER CHARGES ARE APPROPRIATE.

IN THE PAST, THE MINISTRY OF THE ENVIRONMENT HAS RELIED ON A VARIETY OF CERTIFICATES OF APPROVAL, LICENCES AND PERMITS.

IN ADDITION, CONTROL DOCUMENTS SUCH AS CONTROL ORDERS, REQUIREMENT AND DIRECTION ORDERS AND OTHER ADMINISTRATIVE DOCUMENTS HAVE BEEN USED TO REGULATE AND CONTROL DISCHARGES.

THE MINISTRY INTENDS TO ENFORCE THE CONTROL DOCUMENTS THAT I HAVE JUST DESCRIBED IN A FAIR AND EQUITABLE MANNER.

IT IS CLEAR NOW, THAT THE LIMITS AND REQUIREMENTS AS SET OUT IN THE DOCUMENTS MENTIONED WILL BE THE EXPECTED DEGREE OF COMPLIANCE THE MINISTRY WILL REQUIRE.

ANOTHER SIGNIFICANT ASPECT OF THE MINISTRY'S UNIFORM ENFORCEMENT POLICY IS THAT OPERATORS OF ANY FACILITY WHICH DISCHARGES WILL BE RESPONSIBLE FOR THEIR EMISSIONS AT ALL TIMES.

THIS WILL INCLUDE MEETING CONTROL DOCUMENT REQUIREMENTS DURING START-UP, SHUTDOWN, BREAK-DOWNS, MAINTENANCE AND DECOMMISSIONING PERIODS FOR PROCESS OPERATIONS AND INDUSTRIAL FACILITIES.

INDEED, THE PRINCIPLES AND PROCEDURES THAT THE MINISTRY WILL AFFECT FOR THE ENFORCEMENT OF STATUTES WILL BE APPLIED EQUALLY TO BOTH THE PUBLIC AND PRIVATE SECTORS.

THE FINAL ASPECT OF THE NEW POLICY SETS OUT THAT THE MINISTRY WILL MAKE WRITTEN REQUESTS FOR ACTION TO REDUCE, PREVENT OR ELIMINATE POLLUTION AND THAT REASONABLE TIME FRAMES WILL BE SPECIFIED.

IN CASES WHERE COMPLIANCE WITH WRITTEN REQUESTS IS NOT FORTHCOMING WITHIN A REASONABLE PERIOD OF TIME, THE MINISTRY WILL APPLY FORMAL SANCTIONS UPON THE POLLUTER TO AFFECT COMPLIANCE. SANCTIONS MAY INCLUDE ADDITIONAL TERMS OR CONDITIONS IN APPROVALS OR ORDERS OR PROSECUTION.

THERE ARE OTHER CHANGES COMING. OUR MINISTER HAS SAID THAT POLLUTION WILL NO LONGER BE TOLERATED AS PART OF THE COST OF DOING BUSINESS. HE HAS SAID THAT MANY OF THE LAWS UNDER WHICH WE OPERATE ARE UNDER RIGOROUS REVIEW. IN MANY CASES, PENALTY CLAUSES WILL BE STRENGTHENED. IN EXTREME CASES, A JUDGE WILL BE ABLE TO IMPOSE A JAIL SENTENCE.

IT IS MY HOPE THAT THE IEB WILL DEVELOP AN IDENTIFIABLE IMAGE, AMONGST THOSE CAUSING POLLUTION, OF BEING A FIRM, YET FAIR, ENFORCEMENT GROUP.

IN ORDER TO EFFECTIVELY ALTER THE CONDUCT OF VIOLATORS OF ENVIRONMENTAL LAW IT IS IMPORTANT THAT THE RESPONSE OF THE MINISTRY BE PREDICTABLE.

THE IEB WILL PROVIDE THE PREDICTABILITY BY EFFECTIVELY DETECTING, INVESTIGATING AND CHARGING VIOLATORS. ONCE THIS BECOMES ROUTINE TO US, AND EXPECTED BY POLLUTERS AS THE INEVITABLE CONSEQUENCE OF THEIR ACTIONS, I THINK WE WILL BEGIN TO SEE PROFOUND CHANGES FOR THE BETTER.

THAT, AT LEAST, IS MY FONDEST HOPE, AND THE PRIME OBJECTIVE OF THE INVESTIGATIONS AND ENFORCEMENT BRANCH I AM PRIVILEGED TO SERVE.

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